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CARL G. SIEPMANN

G. P. ENGELHARDT

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ENTOMOLOGICA AMERICANA

VOL. XIII (n. s.)

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No. 1

COMPARATIVE SKELETAL MORPHOLOGY OF THE NOCTUID TYMPANUM¹

BY A. GLENN RICHARDS, JR., ROCHESTER, N. Y.

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I. INTRODUCTION

The tympanum is a specialization which has arisen at least three times in the Lepidoptera. Being absent from the Jugatae and all of the "micro-families" as well as many of the highest groups it must be looked upon as a rather recent development. For convenience the families may be divided into three groups which will be found to correspond very well with known relation-

¹ A thesis presented to the Graduate School of Cornell University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

ships except in one case. These are: 1. the thoracic type confined to that group of families known as the Noctuoidea; 2. the first abdominal type (on the first abdominal segment) found in the Geometroidea, Drepanoidea and many of the Pyralidoidea; and 3. the second abdominal type (on the second abdominal segment) confined to the small superfamily the Uranoidea. All of the other groups of moths, as well as the butterflies, lack any semblance of this organ.

Despite its great similarity throughout, the tympanum of the first abdominal segment probably arose at least twice since no one would like to relate the Pyraloids so closely to the Geometroid-Drepanoid stem, and because only the higher groups of Pyraloids possess a tympanum. However the Geometridae, Drepanidae and Thyatiridae (Cymatophoridae) are all closely related and may well represent a single origin of the organ. This abdominal type is located on the anterior part of the segment, ventral to the spiracle, and has four scolopalae faced in the opposite direction from those found in the Noctuids.

The type of tympanum found on the second abdominal segment is confined to the Uraniidae and Epiplemidæ. It is reduced or variously developed in the Epiplemidæ, but in the Uraniidae, as described by Eltringham (1923), it is well developed and exhibits a striking and fundamental sexual dimorphism. In the males the tympanum is postspiracular and covered by a posteriorly projecting flap of the lateral body wall of the same segment. In the females it is prespiracular and covered by a flap-like evagination of the metathorax. In the former case (males) the scolopalae have the same relations as those found in the Noctuids (where the tympanum is also on the posterior part of the segment), whereas in the latter (females) the scolopalae have the opposite orientation as found in the Geometers and Pyralids.

The thoracic type is found in various stages of development in the lowest family of the Noctuoidea, the Diophtidae. The lower members of this family have an extremely rudimentary organ whereas the higher forms possess a tympanum of varying degree of perfection (Forbes, 1922). All the members of the other families have a well developed organ except wingless females (Lymantriidae) and possibly certain others.²

² European species of *Syntomis* lack a tympanum but possess a counter tympanal membrane according to Eggers. *Doa* has a tympanal membrane, but no counter tympanal membrane.

The Noctuid³ tympanum is found on the metathorax near its junction with the abdomen, and will be described in detail later. The two scolopalae point towards the tympanal membrane as is also the case in the male Uraniids, but the reverse of the female Uraniids, Pyralids and Geometers where the tympanum is pre-spiracular. For a complete description of the histological details the reader is referred to Eggers (1919 and 1928).

The present paper deals exclusively with the thoracic type, especially the quadrid Noctuidae, and is confined to the sclerite homologies and a comparative morphology of the grosser structures and accessory structures in the various genera and subfamilies of the Noctuoidea.

II. LITERATURE

The lepidopterous tympanum was first commented on by Swinton (1877) and then by Sharp (1899) for the Uraniidae. A number of short notes followed. The most important was one by Jordan (1905) which divided the families into the same groups as those of Eggers, but made the mistake of locating the organ one segment further posteriorly than it actually belongs. In 1912 Eggers published a preliminary note on the Noctuidae closely followed by his professor, v. Kennel (1912), on the Geometridae and Pyralidae. When the war delayed the publication of his thesis Eggers (1916) published another brief summary of his work at about the same time as Forbes (1916), working without a knowledge of Eggers's and v. Kennel's papers of 1912, published a preliminary report mainly dealing with phylogenic implications. Then in 1919 Eggers's thesis was published. It covered the literature to date, the distribution of the organ in the various families of the Lepidoptera, and the gross and microscopic anatomy together with scanty accounts of the physiological and embryological aspects in the Noctuidae. In a later paper (1925) he has treated the physiological side more fully, and in this paper I have given the sclerite homologies and a comparative morphology of the skeletal structures, leaving the embryological aspects for a later date. Subsequent to Eggers and v. Kennel, Eltringham (1923) has published the gross and microscopic anatomy of the Uraniid type (second abdominal segment) in which there is great sexual dimorphism

³ In the Noctuoidea are included the Dioptidae, Notodontidae, Thaumatopeoidea, Hypsidae, Pericopidae, Coecytiidae, Lymantriidae (Liparidae), Arctiidae, Lithosiidae, Syntomidae (Amaetidae), Nolidae, Noctuidae and Agaristidae.

even of histological details. Snodgrass (1926) and McIndoo (1929) briefly review the subject, and Eggers (1928) has recently published a large work covering all the chordotonal organs of the Insect world. For extended bibliographies and a discussion of the older literature the reader is referred to the excellent works of Eggers (1919 and 1928).

III. TECHNIQUE

Two methods were employed depending on whether or not sufficient material was on hand to sacrifice a specimen. If a whole specimen was to be used the wings were snapped off at the base and the specimen placed in boiling water for several minutes to soften and wet thoroughly. The head and end of the abdomen were snipped off with scissors (if a mounted specimen was being used the pin was removed at this point), and the thorax and remainder of the abdomen split longitudinally with a razor blade (best begun ventrally between the coxae). The pieces were then placed in cold caustic potash (5-10% KOH) for a variable length of time, depending on the size of the specimen involved (15-30 minutes or more), and then the solution raised to the boiling point. For a study of the tympanum it is better not to boil any except the largest specimens, but to remove the pieces to water as soon as the solution begins to effervesce. The specimen is then cleaned with the use of needles and a camel's hair brush under a low power microscope, and preserved in alcohol for study.

When a specimen could not be spared conveniently or when for purposes of identification it was desirable not to ruin the specimen, the region was dissected out and the insect respread. This is done by placing the specimen in a relaxing jar overnight or until thoroughly softened, and then cutting out this region of the body with a sharp lancet. The best results were obtained by sticking the lancet through the second abdominal tergite and cutting anteriorly into the thorax as far as desired; then inverting the specimen and splitting between the coxae; next cutting the lateral membrane between meso- and metathorax and through the mesoscutellum to the first longitudinal incision, making certain to cut sufficiently deep to sever the underlying muscles and mesophragma. The region may now be worked free with the lancet tip and any stray strands cut; finally the lateral abdominal wall is snipped loose with fine-pointed scissors. The wing may be removed at the base and the specimen placed on the spreading boards to dry—the one wing being replaced later with a drop of shellac. The amputated piece

is placed in boiling water and finally potashed as above. This can be done for all except the smallest species of Noctuidae, and it leaves the specimens in good condition if carefully executed.

To facilitate later study it is convenient to cut off the mesophragma near its base in order to have an unobstructed view of the tympanal frame.

IV. GENERAL DESCRIPTION OF THE TYMPANAL REGION

In the Noctuoidea the tympanum is located in the posterior part of the metathorax in the region between the epimeron and postnotum.⁴ Externally the tympanal cavity is visible as a depression just postero-ventral to the hind wing at the junction of the thorax with the abdomen, but in some forms is so completely concealed by scales and accessory structures that it is invisible in a spread specimen. However the external features are quite easily seen in denuded specimens (figs. 1-4).

Dorsally a thoracic segment is composed of prescutum, scutum, scutellum and postnotum (postscutellum, parapteron). The prescutum is infolded and need not be considered here. The scutum is the largest sclerite of the dorsal wall but is not involved in the tympanal modifications. The scutellum is smaller and laterally becomes continuous with the posterior margin of the wing; just posterior to the base of the wing this is expanded to form the alula from which many long scales project posteriorly and ventrally over the tympanal cavity. In some forms the alula is greatly expanded and may even be strongly chitinated, forming a large flap over the tympanal cavity. The remaining part, the postnotum, is greatly modified, as well as the adjacent parts of the first abdominal segment. These will be discussed fully below.

The lateral and ventral sclerites have been thoroughly dealt with by Shepard (1930), and it is sufficient for our purposes to say that the lateral body wall of this segment is divided by a dorso-ventral suture into an anterior part, the episternum, and a posterior part the epimeron. As a rule the secondary suture dividing the epimeron into an anterior portion, the preepimeron, and a posterior portion, the epimeron proper, is well developed in forms with a tympanum; the dorsal portion of the epimeron proper becoming greatly modified in the transformations leading to the formation of the tympanum.

⁴ The exact boundaries of these sclerites as well as the origin of the pockets will be discussed in a later section.

As stated above the main tympanal modifications affect the epimero-postnotal region (fig. 1). At its dorso-posterior corner the epimeron sinks inward somewhat and becomes membranous, thence passing over into the transparent, iridescent tympanal membrane (*tymp.*) which is supported by a heavy semielliptical framework open anteriorly. Between the epimeron proper (*epm.*) and the tympanal membrane there is usually a small sclerite, the "nodular sclerite," which supports the tympanal membrane anteriorly ("Epaulette" of Eggers). It is usually a narrowly elongated sclerite lying free in the membrane, but in a few cases is attached at either or both ends of the tympanal frame (see figs. 20, 21, 26, 36 and 105). It has manifold variations, but as far as checked seems to be specifically constant. In some species it is greatly reduced or even lacking. The region anterior to the nodular sclerite when membranous is referred to as the "accessory" or "false" tympanal membrane.

The tympanal sense organ (chordotonal string) is attached to the center of the tympanal membrane at a point indicated by a light opaque speck in the otherwise transparent membrane (shown in fig. 1 as a black dot).

Facing the insinking of the thoracic wall is a similar opposing one on the first abdominal segment. The pleuron of this segment forms the posterior wall of the tympanal cavity, and, in addition, has a secondary lateral development, the hood, which is an evagination extending laterally and anteriorly so as to cover the posterior part of the tympanal cavity. Its scales, together with those of the alula, form a more or less complete covering (mainly dorsal) for the delicate naked membranes within. In the Noctuidae the hood is always postspiracular except in the Herminiinae where it is pre-spiracular (fig. 3). Eggers says that these two types of hoods are not to be homologized. However this may be as regards families I am not certain, but within the Noctuidae I am extremely skeptical of their distinctness. The lateral type of hood is shown in figure 1 with the spiracle under its center. The subdorsal type with the spiracle outside is seen in figure 3 (hood prespiracular); this same type may also be found in other groups with a postspiracular hood (spiracle under hood). The "two-hooded" condition characteristic of the Plusiinae is shown in figure 4 (this second hood may be merely a development of the small ventral lobe seen in figure 1. Compare the other Plusiine sketches). And finally some forms have lost the hood entirely as in figure 2 (Pantheinae and certain other scattered forms).

The heavy supporting part of the hood is the internal wall (fig. 5a), but in the Erebine-Catocaline complex this is frequently supplemented by another secondary chitinization (fig. 5b). In reality these are separated from one another by a band of membrane though at first glance from the side they seem to represent a single, uninterrupted chitinization.

Associated with the tympanal membrane is a second one, the counter tympanal membrane (*c. tymph.*) ("Gegentrommelfell" of Eggers), which lies dorso-medial to the true tympanal membrane. It also lies in a special cavity which, however, being merely a slit is not visible externally except in rare cases such as *Raphia* (fig. 2). These counter tympanal cavities are developments of the lateral part of the intersegmental groove, and, accordingly, are not complete dorsally from one side to the other though in extreme cases they may be separated by only a thin membrane. Laterally they become continuous with the true tympanal cavities. The counter tympanal membrane is separated from the true tympanal membrane by the framework to be discussed below. Internally it is bounded by the same air sac, and seems most likely to serve as a resonator (Eggers). When the counter tympanal membrane is absent the tympanal air sac extends anteriorly beyond the nodular sclerite onto the "accessory tympanal membrane."

It is interesting to note, as Eggers has, that the counter tympanal cavity may enlarge internally because it does so at the expense of the large abdominal air space, but that the true tympanal cavity must enlarge by the development of secondary structures surrounding it since its internal development would interfere with the adjacent vital organs and muscles.

Due to the rigidity of the tympanal frame there is a nonflexibility between the thorax and abdomen incompatible with movement. This is overcome by the loss of chitinization in the middle of the first abdominal segment to allow an intrasegmental flexure.

Turning to the internal features we recognize many of the same structures. In figure 6 I have attempted to throw these features into three dimensions and in figure 7 have illustrated the same insect in the diagrammatic representation which will be used throughout the body of this paper. The most prominent feature now is the tympanal frame ("lamelle" of Eggers) with its four pockets, but tympanal and counter tympanal membranes, nodular sclerite, scutum and scutellum will serve for orientation (the anterior end in the internal drawings is the right of the figure). Usually these pockets are located in the same relations as here;

that is, two dorsally facing in opposite directions with their bases together; one on the posterior side opening ventrally; and a large double-pocket at the postero-ventral corner. For convenience of reference these pockets have been numbered I-IV respectively, beginning with the most dorso-anterior one. Below pocket IV the epimeron extends ventrally to the coxa, but from the lower medial corner of the pocket a chitinous band passes ventrally and anteriorly. This is part of the dorsal margin of the epimeron which further on becomes continuous with the dorsal margin of the furci-sternite. Its relation to the margin of pocket IV will be referred to later where for convenience it will be termed the "*band*" (compare figs. 27 and 34, etc.). Just dorsal to the subalar sclerite is a scutal phragma (*sc. ph.*) which serves as an internal brace for the anterior end of the tympanal air sac. This air sac extends from slightly anterior to the nodular sclerite posteriorly to the intersegmental groove. Its outer wall is fused with the tympanal and counter tympanal membranes, and the cavity within its interior is connected with the main tracheal system by a single small branch from the center of the medial surface. This air sac always covers the first three pockets, but, as a rule, only partially covers the IVth; at times it may be more or less intimately fused with the IIIrd and less often with the IVth. The line of fusion with pocket IV is indicated by a line labeled "*x*" in figure 7.

In the two genera *Catocala* and *Ophideres* (figs. 89 and 90) there is a small projection from the tympanal frame between pockets I and II or from the ventral border of pocket I. This is the "Bügel" of Eggers, and, in *Catocala* at least, serves for the attachment of the tympanal nerve as it passes medially towards the metathoracic ganglion. None of the other genera examined possess such a structure; in which case Eggers says that the nerve is attached to the frame itself. How far the various knobs on pocket I enter into this is uncertain. In *Plusia* (see fig. 109) it serves both as a support (stress-line) for the tympanal air sac and as an attachment for the chordotonal string. A comparison of other forms suggests the same thing (compare figs. 65, 109, 139, 140, etc.).

From the upper corner of the frame the large, heavily chitinized, tergo-pleural suture of the first abdominal segment extends posteriorly as the main thoracico-abdominal brace. It also forms one side of the frame of the counter tympanal membrane and one wall of the counter tympanal cavity.

The outline of the hood, when present, is shown by a dotted line (as in fig. 7); the spiracle of the first abdominal segment is also

outlined (dotted if behind frame in drawing). However this type of representation will not show whether the spiracle is inside or outside the hood (hood pre- or postspiracular), and reference must be made to the text for this point. Also there is a ventral fovea on the first abdominal segment shown by a dotted line in figure 2. Muscles are attached to this, but it will not be considered further in this paper.

V. COMPARATIVE MORPHOLOGY OF THE NOCTUID TYMPANUM

HERMINIINAE

This group, the Herminidae of Guenée and the Heliini and Herminiini of Smith, has not received general recognition in recent years, and the genera concerned have been scattered among others of quite different structure until the group was revived by Forbes (1918). From our point of view they may be defined as Noctuids with a prespiracular hood (fig. 3),⁵ and accordingly from a tympanal standpoint are the most distinct of all the Noctuid subfamilies. With the exception of the six lowest genera treated here⁶ plus a number of forms from the old world tropics, the group is quite homogeneous in that the males all have a modified fore tibia. Many of the genera also possess a knot-like modification of the antennae of the males.

As stated above the prespicular hood is the best character of the group. It is well developed, either rounded or squarish, and lies dorso-anterior to the spiracle except in *Paraherminia* and *Dercetis*. The palpi and legs are long; the thoracic segments are strongly slanted posteriorly; the metascutellum is broad and low, and all the parts are closely scaled. The alula is normal and small, and the nodular sclerite well developed. Internally the structures are remarkably constant throughout, and remind one of the condition found in the Hypsididae from which the Noctuids are thought to have been derived. Pocket I moderately developed; II well developed and usually symmetrical though frequently reduced on the dorsal side; III elongated with a small mouth; IV primitive and except in *Paraherminia* not complete anteriorly. Counter tym-

⁵ *I.e.*, spiracle outside the hood. This is the primitive condition found in all other Noctuid families except the Agaristidae and Nolidae. Judging from the basal group this is a derived condition and not a direct hangover from Hypsid ancestors.

⁶ *Paraherminia*, *Dercetis*, *Herminia*, *Camptylchila*, *Pseudaglossa* and *Reabotis*.

panal membrane and cavity normal. Frequently the epimeron is noticeably swollen just ventral to pocket IV, but this is not homologous with the swelling seen in a denuded *Plusia* (enlarged pocket IV).

Paraherminia (fig. 8) and *Dercetis*⁷ are placed as the lowest genera of Herminiinae although the spiracle is slightly under (ventro-anterior to) the greatly reduced hood. *Paraherminia* is the only form in the group with a complete anterior boundary to pocket IV (resembling certain Rivulinae in this respect). *Dercetis* is the same as *Paraherminia* except pocket IV which is as in *Herminia*. *Herminia* (fig. 9) has the pockets slightly different, but fundamentally the same; however the spiracle is far outside (posterior to) the hood, much more so than in any other Noctuid examined. Also pocket IV in these three genera differs somewhat from that in the main body of Herminiinae in having the posterior wall curved anteriorly at its ventral end.

As interpreted here these three genera, representing a rather large group in the old world tropics, form a connecting link between the Herminiinae and Rivulinae (normal fore tibia, hood-spiracle relationship and pocket IV). A similar pocket IV is rarely found among our American species (compare *Plusiodonta* and the South American *Aglaonice*).

Next is the very homogeneous group composed of *Camptylorchila* (*Epizeuxis* auct.) (fig. 10), *Pseudaglossa* and *Reabotis* (fig. 11). The hood is rounded and subdorsal with the spiracle just outside on its lower margin (opposite mouth of pocket III). The internal features are also quite typically Herminiine except that pocket II is slightly modified in *Camptylorchila*. The first two of these genera make up the Heliini of Smith, while the third has been heretofore treated as among the pseudo-deltoids near *Gabara*. This group is distinguished from the following by the short, unmodified fore tibia in the males.

The remaining genera of Herminiinae are essentially alike (figs. 12 and 13) though there is some difference in the size of the mouth and the length of pocket III and in the symmetry of pocket II. This later character must be used with extreme caution since it varies greatly in a single specimen according to the angle from which it is being viewed.

⁷ *D. bilineata* B. & Mc.D. has been removed to *Micrastis* by Barnes and Benjamin. I have not seen the species.

*North American Forms Examined*⁸

<i>Bleptina caradrinalis</i> Gn.	<i>Phalaenostola larentioides</i> Grt.
* <i>Camptylochila aemula</i> Hbn.	<i>Philometra metonalis</i> Wlk.
“ <i>americalis</i> Gn.	* <i>Pseudaglossa lubricalis</i> Geyer
“ <i>rotundalis</i> Wlk.	<i>Reabotis immaculalis</i> Hlst.
<i>Chytolita morbidalis</i> Gn.	<i>Rejectaria albisinuata</i> Sm.
<i>Dercetis vitrea</i> Grt.	<i>Renia salusalis</i> Wlk.
<i>Hormisa absorptalis</i> Wlk.	* <i>Tetanolita mynesalis</i> Wlk.
<i>Hypenula cacuminalis</i> Wlk.	<i>Zanclognatha cruralis</i> Gn.
* <i>Lascoria ambigualis</i> Wlk.	“ <i>laevigata</i> Grt.
* <i>Palthis angulalis</i> Hbn.	“ <i>jacchusalis</i> Wlk.
<i>Phalaenophana pyramusalis</i>	“ <i>ochreipennis</i> Grt.
Wlk.	<i>Xylormisa louisiana</i> Fbs.

RIVULINAE

This subfamily is proposed to include the rather distinct basal group of Noctuid genera which, however, contain a number of forms of doubtful relationship. Although the *Herminiinae* are placed first because of the hood-spiracle relationship, this is the most primitive subfamily of the *Noctuidae* and the one from which the *Herminiinae* and higher subfamilies seem to have been derived.

The subfamily is very difficult to describe on superficial or general characters although presenting a certain common habitus throughout. They are small moths with delicate wings. The antennae are ciliated or pectinated, never possessing a knot-like modification; palpi porrect or ascending, but never as greatly developed as in many *Herminiinae*, *Hypeninae* and *Erebinae*. The venation is variously modified: some genera have the usual deltoid venation (*Salia*, etc.); others have a double areole (*Boletobia* group); while others have no areole and may or may not have lost a vein from the fore wing (*Rivula*, *Hypenodes*, etc.). The metascutellum is usually broad and low; the thoracic segments not strongly slanted posteriorly as in the *Herminiinae*, and the legs of moderate length and unmodified. Incidentally this group includes all the Noctuid genera I know to lack the ocelli.⁹

The hood, as in all the subfamilies except the *Herminiinae*, is postspiracular (spiracle out of sight under hood) or rudimentary. Alula normal; nodular sclerite normal or rudimentary. Pocket I

⁸ More than one specimen, frequently many specimens, have been dissected of those species preceded by an asterisk (*).

⁹ *Acidaliodes*, *Hypenodes*, *Hypenopsis*, *Menopsimus* and *Parahypenodes*.

well developed; II various, sometimes greatly enlarged or passing along the base of III to the posterior edge of the frame or extending ventrally to IV; III small, rarely rudimentary or lost; IV usually double (both margins meeting the "band"—see under sections 4 and 8) and when single (margins fused, not reaching the "band") the other characters not as in the *Erastrinae*.

Rivula (fig. 14) seems to be the most primitive Noctuid genus examined. The pockets are scarcely more than a ridge-like frame, and quite similar to their Hypsid ancestors. *Salia* (fig. 15) is much the same but somewhat more highly developed. *Hypenodes* and *Hypenopsis* (fig. 17) are quite similar to one another and illustrate the lines of development leading into the central group of the subfamily. Pocket II is developing along the inner margin of the frame and pocket IV is enlarging (in *Hypenodes* intermediate between *Hypenopsis* and *Salia*). *Mycterophora longipalpata* and *rubricans* (fig. 18) are much the same, but with pocket III greatly reduced, but *M. inexplicata* (*slossoniae*) (fig. 19) is markedly different and more like *Parahypenodes* (fig. 20), both of which have the margin of pocket IV distinct from the "band." As shown by the variations of *Prosoparia* to be discussed below, *Menopsimus* (fig. 21) is simply an aberrant member of this group in which pocket II extends completely across the base of pocket III and in which the mouth of pocket III has enlarged dorsally all the way to the base. The hood is reduced and membranous in *Mycterophora* and *Menopsimus*, and entirely lost in *Parahypenodes*.

Oxycilla (fig. 22) and *Zelicodes* form an offshoot from this group. In *O. tripla* pocket IV is almost closed as shown in figure 22, but in *O. malaca* and *Zelicodes* it is more open (similar to *Mycterophora rubricans*).

Dyspyralis (fig. 23) and *Acidaliodes* (fig. 24) have lost pocket III, perhaps as the end result of the type of reduction shown in the genus *Mycterophora*. *Acidaliodes* is the only genus lacking ocelli outside the homogeneous *Hypenodes-Parahypenodes* group, and looks like a *Mycterophora* which having lost pocket III has developed pocket II along both sides of the frame to pocket IV instead of merely down the anterior side. *Dyspyralis* with its peculiar dorso-posterior development of the tympanal air sac is not so easily reconciled, but looks like a derivative of the same type.

Melanomma (fig. 16) with pocket IV intermediate between *Salia* and *Oxycilla* is a peculiar genus tentatively placed with these. *Sigela* (fig. 26) lacks a hood and has pockets II and III much as

in the central group of Rivulinae, but pocket IV is wrong for this subfamily as well as for the Erastrinae where it has been placed heretofore. The only other place where a similar pocket IV is encountered is in the *Herminodes-Gabara* series of Erebinæ.

The genera *Prosoparia* and *Stellidia* also belong in this subfamily, but show considerable variation. *P. tenebrosa* is the only species examined in which the two sides of a single specimen were observed to differ from one another. Figure 25 shows the right side of one specimen (compare *Parahypenodes* and *Sigela*) while the left side of the same specimen has pockets I and II rudimentary; III small and almost closed; and IV sloping away ventrally with its anterior and posterior walls never joining one another. A second specimen was similar to figure 25, but its right side had pockets II and III just as in *Menopsimus*, and its left side had pocket III even more open. *P. perfuscaria* and *S. vanata* had pocket IV rudimentary as in the left side of the first specimen of *tenebrosa*, but not enough material was at hand to check bilateral and intraspecific variation in these species.

The European *Parascotia fuliginaria* has pockets II and III as in figure 25, but pocket IV as in *Mycterophora inexplicata*. And the European *Madopa*, which looks just like *Salia* superficially, has pocket IV as in *Hypenopsis*, etc.

North American Forms Examined

<i>Acidaliodes flavipars</i> Dyar	<i>Oxyella malaca</i> Grt.
<i>Dyspyralis illocata</i> Warr.	“ <i>tripla</i> Grt.
“ <i>nigellus</i> Stkr.	<i>Parahypenodes quadratis</i> B. & McD.
<i>Hypenopsis macula</i> Druce	
<i>Melanomma auricinctaria</i> Grt.	<i>Prosoparia perfuscaria</i> Grt.
* <i>Menopsimus caducus</i> Dyar	<i>Rivula propinquialis</i> Gn.
<i>Mycterophora inexplicata</i> Wlk.	<i>Salia interpuncta</i> Grt.
“ <i>longipalpata</i>	<i>Sigela basipunctaria</i> Wlk.
“ Hst.	<i>Zelicodes linearis</i> Grt.
“ <i>rubricans</i> B. & McD.	

HYPENINAE

At present we are still unable to make any really satisfactory subdivision of the Hypenine-Erebine-Catocaline complex, but we can point out a number of more or less natural groups all of which are markedly interrelated. The most homogeneous of these includes the *Hypena* series, and is treated here as a separate subfamily. Tympanally it is well set off from the Erebinæ except for the

genera *Plusiodonta* and *Scoliopteryx*,¹⁰ and is connected via *Pleonectyptera* with the Rivulinae on the one side and the *Pangrapt-Herminodes* series and thence the typical Erebiniae on the other (plate 20).

Metascutellum moderate, usually higher than in the Rivulinae. Hood always well developed, full or subdorsal¹¹; alula normal, and nodular sclerite usually linear. Pockets I and II various; III long and fused with the air sac; IV always double, often overhanging ventrally.

Group 1: *Pleonectyptera* (fig. 27) is the only American genus placed here along with the European *Aventia* which is quite similar. The tympanum is quite unspecialized, and appears to connect the Hypeninae proper with the Rivulinae and Erebiniae. The only point of modification is the slightly overhung pocket I.

Group 2: This lashed-eyed group is altogether similar throughout, and includes *Anepischetos*, *Bomolocha*, *Hypena*, *Lomanaltes* and *Plathypena*. Figure 28 shows the structure of all except *Lomanaltes* (fig. 29) which is slightly modified. Pocket IV is becoming somewhat reduced and overhung ventrally though it is a different type from that in the Erebine series. In the Hypeninae pocket IV is always double, and any variations are clearly modifications of a double pocket. The higher Erebiniae, however, are derived by reduction from forms with a single pocket (*Pangrapt-Herminodes*), and accordingly present a different habitus even when reduced to the stage represented by the Hypeninae. Because of this origin *Scoliopteryx* seems certainly an Erebine, but *Plusiodonta* is more questionable.

Group 3: Characterized by the subdorsal hood and the further modification of pocket IV. *Hormoschista* is close to the Hypenini; the hood being intermediate between *Hypena* and *Prothymia*; pocket I full and deep, and IV slightly more open. In this genus the scutal phragma is greatly attenuated and reaches to beyond the middle of the nodular sclerite. *Ommatochila* (fig. 30), *Cryphia* (fig. 31) and *Protocryphia* are usually placed in the Erastrinae, but have the typical tympanum of this group.¹² *Protocryphia*

¹⁰ The immediate *Hypena* group and *Scoliopteryx* are the only quadrifids with lashed eyes outside the Plusiinae. The caterpillar is also similar.

¹¹ The spiracle lies opposite the mouth of pocket III, but the hood varies in relation to these. Compare figs. 27 and 32.

¹² One might add that *Cryphia* and *Protocryphia* will key to the Erebiniae, not the Erastrinae, on Hampson's M_2 character.

differs from *Cryphia* in having pocket II deep and overlapping III. The nodular sclerite is not linear in either genus, and the spiracle is higher on the abdomen than usual (opposite base of pocket III instead of mouth). *Spargaloma* is similar to *Ommatochila* except that pocket I is shallow and not overhung, and pocket II deeper and overlapping pocket III. *Prothymia* (fig. 32) is more primitive in some respects, but its hood is further dorsal than in the other genera. The tropical *Aglaonice snelleni* belongs here, and as noted before *Plusiodonta* shows striking similarities.

North American Forms Examined

<i>Anepischetos minualis</i> Gn.	<i>Ommatochila mundula</i> Zell.
<i>Bomolocha baltimoralis</i> Gn.	* <i>Plathypena scaber</i> Fabr.
* " <i>madefactalis</i> Gn.	<i>Pleonectyptera historialis</i> Grt.
<i>Cryphia pervertens</i> B. & McD.	" <i>pyralis</i> Hbn.
<i>Hormoschista latipalpis</i> Wlk.	<i>Prothymia semipurpurea</i> Wlk.
<i>Hypena humuli</i> Harr.	<i>Protocryphia secta</i> Grt.
<i>Lomanaltes eductalis</i> Wlk.	<i>Spargaloma sexpunctata</i> Grt.

THE EREBINE-CATOCALINE COMPLEX

All the remaining quadrifid genera, except the small subfamilies to be treated later, are grouped together into this complex series. Hampson's division based on spined vs. unspined tibia is a purely artificial one as shown by such genera as *Arcte* and *Pararcte*, and by the European *Leucanitis* which is just like our American *Synedas* in tympanal and other characters except that the mid-tibia are spined, and by other similar cases.

All the North American genera have been examined, and in addition as many exotic forms (both old and new worlds) as possible at present. However this series has its centers in the tropics of the two hemispheres and can be satisfactorily treated only on a world basis. This is impossible at the present due to the large number of genera unavailable, but it is thought that a thorough representation of the groups has been examined.

In the other subfamilies species within any single genus are almost always constant, but in the Erebine-Catocaline complex practically every species is slightly different though fundamentally similar to the other species of the same genus and more different from other genera. A number of rather well defined groups (tympanally) stand out each containing some atypical forms, but usually these series intergrade and show characters of every other group also. Accordingly the present arrangement which is based

upon the tympanum supplemented and tempered by other characters must be considered extremely tentative until many more forms and many other structures have been studied and correlated.

The metascutellum tends to be high and narrow. The alula unmodified and small in all groups except *Alabama* and *Anomis*; the hood usually well developed and rarely subdorsal as in the Hypeninae. As previously noted the hood proper is frequently supplemented by a second pleural chitinization of the first abdominal segment (fig. 5, a and b) which may even make that part of the body protrude as a whole (fig. 1). The internal features are too various for generalization.

Group 1: This is the most primitive of the subfamily and shows relationship to *Pleonectyptera*. The metascutellum is intermediate in most, but high and narrow in *Sylectra*; alula normal; hood present except in certain species of *Gabara*, either single or double. Pocket IV single and leading up to the secondarily double type of the higher Erebinæ. *Pangraptæ* (figs. 6 and 7), *Isogona* (fig. 33) and *Metalectra* (fig. 34) represent the primitive Erebine type especially for pocket IV. *Pangraptæ* was used as the type of the general description and need not be rediscussed. *Sylectra* is clearly a modification of this leading toward the higher Erebine type. *Diallagma* (fig. 35) and *Egryrlon* (fig. 44) are both near to *Isogona* and *Metalectra*.

From this *Pangraptæ-Isogona* series we pass insensibly over into the *Herminodes-Gabara-Scolecocampa* series where every species has a slightly different tympanum conforming to the same general style. The species intergrade hopelessly from a generic point of view (single genus?), and one must speak of specific points to say that one species is high and another lower. From *Isogona* we pass through *Herminodes* (figs. 36-37) and *Scolecocampa* (figs. 38-39) into the western species of *Gabara* (fig. 40), and thence into a separate side line leading to the extremely modified eastern species of the genus. Twelve eastern specimens of *Gabara* were examined, but I cannot be positive of the species even after comparison with the U. S. N. M. and Barnes Collections. As near as I can say figure 41 is either an odd *bipuncta* (Tenn.) or a *n. sp.*, and one specimen of *humeralis* was the same; figure 42 with some slight variation in pocket III will hold for two Connecticut specimens of *bipuncta*, three *humeralis* and one *n. sp.*? from Tennessee; while figure 43 represents two specimens of *pulverosalis*, one of *bipuncta* (Conn.) and one of *umbonata* (= *humeralis*?). At any rate figures 41-43 represent the extent of variation. The chief

modifications concern pockets III and IV which become greatly reduced—and pocket III even lost in some (fig. 43). As is usual when pocket III is lost, pocket II extends ventrally to pocket IV. Concurrent with these are the reduction and final loss of the nodular sclerite and the hood. *Pseudorgyia* (fig. 45) is similar to some species of *Herminodes*, and *Phiprosopus* (fig. 46) is also a member of this group. Of the two specimens of *Phiprosopus* examined one had pocket IV as in *H. guttata*; the other was aberrant as shown in figure 46—the other features were alike in the two specimens.

Group 2: Includes a rather artificial group of genera which connect the first group with the central groups of Erebinæ. *Strenoloma* (fig. 47) is much like Group 1. *Hypsoropha* (fig. 48) is less so, and the two N. A. species differ from one another in certain quantitative respects. *Calpe* (fig. 49),¹³ *Rhescipha* (fig. 50) and *Capnodes* (fig. 51) are only slight modifications of the same style (the South American *Teinanomis*, as expected, is identical with *Rhescipha*). These then grade over into the higher Erebine style via modifications such as shown by "*Anticarsia*" *schausi* (fig. 53), *A. gemmatilis* (fig. 54) and *Antiblemma* (fig. 55).

Alabama and *Anomis* (fig. 52) are extreme forms in this general neighborhood. Each has a full hood and an enlarged alula (however not chitinized as in the Tarachini). Pocket IV is somewhat more reduced in *Alabama* than *Anomis*, otherwise the two genera are about alike.

Plusiodonta (fig. 56) is placed here tentatively though tympanally it has more in common with the Hypeninae (note full hood and pocket IV).

Group 3: The *Melipotis-Syneda* series. This is probably the best defined of all the Erebine groups. The hood and alula normal; tympanal membrane and nodular sclerite quite characteristic; pockets various, but usually I modified, II and III moderate, and IV double and flanged.

Phoberia (fig. 57) has the characteristic nodular sclerite and pocket I as in *Ulosyneda* (fig. 58). *Cissusa* (fig. 59) is much the same but has pocket I modified by a pouch-like evagination. *Melipotis* (fig. 60), *Bolina* (fig. 61), *Cirrhobolina* (fig. 62), *Drasteria*, *Syneda* (fig. 63), *Litocala* (fig. 64) and *Hypocala* (fig. 65) all possess the same characteristic features (shape of nodular sclerite, pouched pocket I and flanged pocket IV). *Drasteria* is almost

¹³ The tropical *Parachabora abydas* placed in *Calpe* by Hampson has a tympanum more like *Massala* (Group 4).

identical with *Melipotis*. *Panula* (fig. 66) is an extremely aberrant member of the group (compare *Thysania* and *Euclidia*).

The European *Leucanitis* has the wing pattern of some of our American species of *Syneda*, but the mid-tibia are spined. Its tympanum is identical with *Syneda* and affords good evidence of the artificiality of any division on spines.

Group 4: A large group characterized by an overhung or pouched pocket I¹⁴; pocket II reaching III and usually angled on it; III moderate, as a rule not extensively fused with the air sac; IV double and except for *Eulepidotis*, *Massala* and *Toxocampa* distinctly flanged.

Eulepidotis (fig. 100), *Massala* and *Toxocampa* (fig. 67) connect this series with the next by having all the characters of this group except the flange on pocket IV. *Eulepidotis* is the most intermediate and emphasizes the artificial nature of these two groups as split here—it might perhaps better be looked upon as a single group branching in two directions. *Massala* has an enlarged alula and pocket IV as in *Antiblemma*; otherwise it is as in *Toxocampa*.

Bendis (fig. 68) with a small pouch on pocket I and a large flange on pocket IV shows the typical structure of the series. *Epidromia* is quite similar, but the pouch on pocket I is as large as in *Toxocampa*. *Mazacyla* and *Kakopoda* (fig. 69) have a small, pointed, finger-like pouch on pocket I; pocket II reduced though larger in *Mazacyla*; pocket III free, and pocket IV normal. *Yrias* (fig. 70) has the same general style, but pocket I reduced to an overhung one. *Heteranassa* (fig. 71) and *Coenipeta* (fig. 72) are merely somewhat reduced forms of the same style, and *Euparthenos* (fig. 73) a further development of pocket I along the *Yrias* type. *Matigramma* (fig. 74) seems to be reduced from near *Euparthenos*, and *Eubolina* is almost identical, but with pocket I more overhung. *Zale* (fig. 75) and *Zaleops* (fig. 76) are very close to one another, and have pocket IV re-fused into a single pocket.

Selenis (fig. 78) and *Ephesia* (fig. 79) are the only other genera with a flange on pocket IV, but they have pocket I normal though chopped off anteriorly (compare *Tyrissa*, fig. 83).

Corina (fig. 80) and *Safia* (fig. 81) have pocket I unmodified and the flange on pocket IV extremely reduced, but disregarding

¹⁴ A slight retrogression of the margin of the mouth of any pocket with a pouch will obviously end in one with the margin extending into an overhung flap.

spined tibia would be placed with *Zale* and *Zaleops* on non-tympanal characters.¹⁵

Group 5: More or less artificially separated from the last group by the unflanged margin of pocket IV. Also pocket I is never modified as in most of the forms in group IV.

Focillidia (fig. 82) and *Tyriessa* (fig. 83) are rather similar and tend to connect this group with the last. Distinct from these *Hemeroblemma* (fig. 84) and *Latebraria* (fig. 85) lead up to the type found in the large *Blosyris-Erebus* series (fig. 86). *Thysania zenobia* (fig. 87) like certain other scattered forms is aberrant in pocket IV, but the South American *agrippina* is intermediate to the *Blosyris* type (unfortunately only one specimen of each species was available for examination). This group with only slight variations includes the dominant series of large tropical Erebines of both hemispheres (spined and unspined tibia).

Catocala (fig. 89) and *Ophideres* (fig. 90) are of much the same tympanal style, and are alike in being the only genera which possess a "bügel" (chitinous projection from the inner margin of the frame). Variation within the genus *Catocala* is extremely minor. The hood is subtriangular (subgenera *Mormonia* & *Catocala* of B. & McD.) or elliptical (subgenus *Eunetis* of B. & McD.); the nodular sclerite varies from simple and filiform to broad and sculptured; the pockets are almost identical throughout though pocket II varies slightly in symmetry from species to species in the first subgenus.

Group 6: This is the rather homogeneous central group of "Catocalinae." Tympanally there is an indescribably different habitus which suggests a separate origin from the conglomerate called Group 2. *Caenurgina* (fig. 91) is the most primitive, though *Parallelia* (fig. 92) and *Argyrostromis* (fig. 93) are much the same. *Celiptera* (fig. 94) is somewhat more modified, and *Euclidimera* (fig. 95) considerably so. Then there is a group of three genera with pockets I and II very small and pocket IV fused into a single one. Of these *Phurys* (fig. 96) is not greatly removed from *Argyrostromis*, while *Doryodes* (fig. 97) and *Cutina* (fig. 98) are slightly more so. Eight specimens of *Euclidia* were dissected; five of these were alike and similar to the last three genera (fig. 99); two had pocket IV open as in *Doryodes*, while the eighth had carried the unification to the same point as shown by *Panula* and *Thysania* (see figs. 66 & 87). And finally *Pelamia* (fig. 77) is much more

¹⁵ One could make a natural subdivision of this group by putting in *Panapoda* as a tympanally aberrant genus and then segregating those genera with relatively small hind wings.

like Group 4, and is the only member of this group with a pouch on pocket I.

Scoliopteryx (fig. 101) seems best placed as an aberrant genus of Group 5 although it shows similarities to the *Hyppena* group in its lashed eyes and caterpillar, and less in its tympanum.

Gonodonta (fig. 102) although an undoubted Erebine is sufficiently peculiar to prevent satisfactory placement at the present. *Panapoda* (fig. 88) and *Siavana* look as though they should be placed with the small hind-winged genera of Group 4 (*Massala*, etc.), but tympanally pocket IV is wrong (compare the similar digression of this pocket in *Thysania*, *Panula* and *Euclidia*).

Noropsis (fig. 103) has an almost vestigial frame with pocket III lost; no hood, and only the barest traces of a nodular sclerite. It has a very vague resemblance to the Pantheinae, but is too aberrant to be safely placed.

Litoprosopus (fig. 104) with two hoods, an evaginated nodular sclerite and a sunken tympanal region with pocket IV bracing it from below, looks like a combination of a Notodontid with a Plusiid. It is probably the most aberrant genus examined.

North American Forms Examined

GROUP 1

Diallagma latiorella Wlk.
Egyrion filaria Sm.
 * *Gabara bipuncta* Morr.
 * " *humeralis* Sm.
 " *obscura* Grt.
 * " *pulverosalis* Sm.
 " *stygialis* Sm.
 " *subniveosella* Wlk.
 " *umbonata* Sm.
 " *n. sp. ?*
Herminodes atrosignata Wlk.
 " *guttata* Schs.
 " *insula* Dgn.
 " *perfasciata* Dgn.
Isogona natatrix Gn.
 " *texana* Sm.
Metalectra discalis Grt.
 " *tantillus* Grt.
 * *Pangrapta decoralis* Hbn.

* *Phiprosopus callitrichoides* Grt.
 * *Pseudorgyia versuta* Harv.
Scolecocampa atriluna Sm.
 * " *liburna* Geyer
Sylectra ericata Cram.

GROUP 2

Alabama argillacea Hbn.
Anomis erosa Hbn.
Antiblemma inexacta Wlk.
Anticarsia gemmatilis Hbn.
 " *schausi* B. & Benj.
Calpe canadensis Beth.
Capnodes placida Schs.
 * *Hypsoropha hormos* Hbn.
 * " *monilis* Grt.
 * *Plusiodonta compressipalpis* Gn.
Rhescipha obtusa Wlk.
Strenoloma lunilinea Grt.

GROUP 3

- Bolina cellaris* Gn.
Cirrhobolina mexicana Behr
Cissusa mucronata Grt.
Drasteria occulta Hy. Edw.
Hypocala andremona Cram.
Litocala sersignata Harv.
**Melipotis jucunda* Hbn.
**Panula inconstans* Gn.
Phoberia atomaria Hbn.
Syneda adumbrata Behr
Ulosyneda valens Hy. Edw.

GROUP 4

- Bendis detrahens* Wlk.
Coenipeta uniloba Gn.
Corina cinctipalpis Sm.
**Ephesia elonympha* Hbn.
Epidromia delinquens Wlk.
Eubolina impartialis Harv.
Eulepidotis ilyrias Cram.
“ *julianatta* Stoll
**Euparthenos nubilis* Hbn.
Heteranassa minor Sm.
Kakopoda cincta Sm.
Massala abdera H.-S.
“ *obvertens* Wlk.
Matigramma laena Grt.
**Panapoda rufimargo* Gn.
Safia bilineata Sm.
Selenis sueroides Gn.
Siavana repanda Wlk.
Toxocampa victoria Grt.
Yrias repentis Grt.
**Zale lunata* Dru.
“ *undularis* Dru.
Zaleops umbrina Grt.

GROUP 5

- Catocala aholibah* Stkr.
“ *amica* Hbn.
“ *badia* G. & R.
“ *cara* Gn.
“ *cerogama* Gn.
“ *coccinata* Grt.

- “ *delilah* Stkr.
“ *epione* Dru.
* “ *flebilis* Grt.
“ *habilis* Grt.
* “ *ilia* Cram.
“ *illecta* Wlk.
“ *innubens* Gn.
“ *insolabilis* Gn.
“ *junctura* Wlk.
“ *messalina* Gn.
* “ *micronympha* Gn.
“ *minuta* Edw.
“ *palaeogamma* Gn.
“ *piatrix* Grt.
* “ *relicta* Wlk.
“ *similis* Edw.
“ *sordida* Grt.
“ *ultronia* Hbn.
“ *vidua* A. & S.

- Erebus odor* Linn.
Focillidia texana Hamps.
Latebraria amphipyroides Gn.
Ophideres fullonica L.
Parallelia bistriaris Hbn.
Peosina (= *Hemeroblemma*)
pandrosa Cram.
Thysania zenobia Cram.
Tyrisa marginata Warr.

-
Gonodonta nutrix Cram.
Litoprosopus coachella Hill.
“ *futilis* G. & R.
**Noropsis hieroglyphica* Cram.
**Scoliopteryx libatrix* Linn.

GROUP 6

- Argyrostromis anilis* Dru.
Caenurgia crassiuscula Gn.
Celiptera frustulum Gn.
Cutina albopunctella Wlk.
Doryodes bistrialis Geyer
**Euclidia cuspidata* Hbn.
Euclidimera caerulea Grt.
Pelamia disseverens Wlk.
Pelamia latipes Gn.
Phurys lima Gn.

STICTOPTERINAE

A small subfamily apparently derived from the higher Erebinæ of Group 4. Tympanally they are extremely close to the Plusiinae, for which, indeed, they would serve as prototype.

The neotropical *Stictoptera clara* (fig. 107) has a large hood with a ventral lobe; slender nodular sclerite; attenuated scutal phragma; pocket I with a large overhanging pouch; II and III short, and IV single and intimately fused with the tympanal air sac. The Indo-Australian *S. melanistis* has the two hoods of the Plusiinae, but the internal details as in *clara*.

Forms Examined

Stictoptera clara Cram.

Stictoptera melanistis Hamps.

PLUSIINAE

This is the most homogeneous and distinct of all the quadrifid groups, but tympanally at least is related to the higher Erebinæ through the Stictopterinae.

The metascutellum is broad and moderately high; the alula normal but sometimes enlarged, and also there is a second hood ventral to the normal one (fig. 4).¹⁶ Pocket I shallow, frequently overhung; II reaching III, sometimes with a small mouth, and in *Abrostola* overlapping III; III moderate and not extensively fused with the air sac; IV very large, swollen, and intimately fused with the tympanal air sac as in the Stictopterinae.

A denuded specimen of Plusiine, Herminiine or certain other forms presents a swollen area of the epimeron ventral to the tympanal membrane. In the Plusiinae this is the greatly enlarged pocket IV ("epimerale akzessorische Tympanalkammer" of Eggers), but in all other forms it is a swollen area of the epimeron ventral to pocket IV.

Abrostola (fig. 108) is the only genus with pocket II overlapping III; it also has the smallest hoods. *Autographa* (figs. 4 & 109) is the most highly developed genus, with enormous hoods and pocket IV. *Chrysoptera* (fig. 110) is somewhat reduced, and *Eosporopteryx* is almost identical. *Palaeoplusia* is close to *Plusia* except that pocket II is not contracted at the mouth. *Plusia* (fig. 111) is slightly different, and *Pseudeva* less so. *Syngrapha* is just like *Autographa*.

¹⁶ This second hood is not heavily chitinized like the first but it projects over the tympanal cavity in the same manner as the "normal" hood.

*Forms Examined*¹⁷

<i>Abrostola urentis</i> Gn.	<i>Eosphoropteryx thyatyroides</i> Gn.
* <i>Autographa brassicae</i> Riley	
“ <i>gamma</i> Linn.	<i>Palaeoplusia venusta</i> Wlk.
“ <i>californica</i> Speyer	<i>Plusia aerea</i> Hbn.
“ <i>precationis</i> Gn.	<i>Pseudeva purpurigera</i> Wlk.
“ <i>simplex</i> Gn.	<i>Syngrapha ignea</i> Grt.
<i>Chrysoptera moneta</i> Fabr.	

EUTELIINAE

This subfamily is generally considered a derivative of the Erebinæ, and if so would be from Group 4 close to the Stictopterinae, but tympanally they have much in common with the Erastrini. The metascutellum is moderate, tending to be narrow; hood small, more or less subdorsal; alula small and unmodified; internal features various.

Aon (fig. 112) has pocket III reduced, and IV conical and flanged. It looks more like an Erastrine than an Erebine. *Eutelia* (fig. 113) has a large flag hanging into the tympanal air sac from the frame just anterior to pocket I; pocket IV is greatly reduced, and there is a membranous second hood ventral to the normal one (compare the Stictopterinae). *Marathyssa* (fig. 114) and *Paectes* (fig. 115) are much more alike than the other two genera. Compare the Erastrine genera (such as *Euaontia*, *Homolagoa* and *Phoenicophanta*) as well as the Erebine genera of Groups 4 and 5.

Forms Examined

<i>Aon noctuiformis</i> Neum.	* <i>Marathyssa inficita</i> Wlk.
<i>Eutelia adulatrix</i> Hbn.	* <i>Paectes abrostoloides</i> Gn.

ERASTRIINAE

Tympanally speaking the Erastrinae seem to have been derived from some point between the Rivulinae and Hypeninae with *Eublemma* as the connecting link. They are distinctly divided into two tribes by the excessive development and chitinization of the alula in one group of genera.

From this subfamily three others are to be derived and possibly a fourth. The Acontiine-Sarrothripine series is derived from among the middle Erastrinae, while the Acronyctine series and thence the other trifold subfamilies and the Agaristidae are derived

¹⁷ *Diloba caeruleocephala* placed here by Hampson has a typical Acronyctine tympanum similar to that of *Trachea* (fig. 143).

from among the higher Erastrinae which retain an unmodified alula. Typical members of the trifold subfamilies are essentially similar to the Erastrinae in tympanal structure. The Euteliinae are derived by Hampson from the Erebiniae, but tympanally they have as much in common with the Erastrinae.

As is the case with certain of the other quadrifid subfamilies, this group has been separated by Hampson on a basis of the intangible M_2 of the hind wing. It may be separated from the Rivuline-Hypenine series by pocket IV which is usually elongated and always single (*i.e.*, margin distinct from "band") except in the connecting genus *Eublemma*. This condition is also encountered in certain Erebiniae though somewhat different there (compare *Egrylon*, fig. 44).

The metascutellum is narrow and high; the nodular sclerite frequently weak but rarely absent (*Erastria* and *Grotelliforma*); the alula normal or modified as to be described later; hood normal, greatly reduced or frequently lacking. In some genera (see *Hemispragueia*) the hood is so reduced that it no longer covers the spiracle, though the hood when present at all is always postspiracular. When the alula is modified the hood is never well developed and usually is entirely absent, but it is rudimentary or absent in many forms with a perfectly normal alula. The thorax as a whole does not slant posteriorly as in most Deltoids, and the legs and palpi are short and without special modifications.

Eublemma (fig. 116) is considered a connecting link to the Deltoids mainly on a basis of pocket IV which is a truly double one with its opposing walls meeting in an angle at the "band." Nevertheless this pocket, as well as pocket II, is showing the same shape and tendencies prevalent in the Erastrinae proper and not in the Deltoids. Also the hood is large and primitive, the alula normal, and pocket III not fused with the tympanal air sac. The metascutellum is not as high in this group as in most Erastrinae.

Erastrini: This tribe includes all those genera in which the alula is unmodified, and is connected with the Tarachini by *Chamyris*, *Cerathosia* and *Diastema*.

The largest and most typical group of genera include *Amiana*, *Cobubatha* (fig. 117) *Erastria*, *Erastriodes* (fig. 118), *Euaontia* (fig. 119), *Exyra*, *Ozarba* and *Sexserrata*. In this group the hood is well developed, usually subdorsal and pointed; pockets I and II usually very shallow with II tending to be lopsided; III not fused with the tympanal air sac, and IV deep and narrow with its margin tending to become an integral part of the tympanal air sac. The exceptions are that in *Amiana* we have the first step of fusion of

pocket III with the air sac; that *Erastria* has pockets I and II deep and lacks a nodular sclerite; and that *Sexserrata* has no hood.

The second group is undoubtedly derived from the above. It includes *Lithacodia* (fig. 120), *Neotarache* (fig. 121) and *Capis* (fig. 122), and is characterized by the extreme reduction of pocket III. Typical species of *Lithacodia* (fig. 120) have a well-developed, rounded hood with the spiracle just beneath the lower corner; pocket I shallow; II deep and reaching the tergo-pleural suture of the first abdominal segment; III and IV about as in Group 1. *L. caduca* and *Neotarache* (fig. 121) have pockets I, II and III reduced with III becoming little more than a transverse ridge, and IV more intimately fused with the air sac. *Caduca* has a rudimentary hood; *Neotarache* lacks a hood. "*L.*" *albidula* and *Capis* (fig. 122) carry the reduction of pockets I, II and III a step further, but IV is somewhat different. *Albidula* has a small hood; *Capis* has none. Venationally and structurally *Capis* is almost identical with *albidula*.

There is a third well defined group composed of *Chamyris*, *Cerathosia* and *Diastema*. These genera have the pockets just as in the Tarachini (fig. 131) (and might therefore if one wished be placed as the most primitive of that tribe) except that the alula is unmodified and that a small hood is present in all except *Cerathosia*. This group is closely related to *Ozarba*, *Cobubatha* and certain other odd genera. The West Indian "*Tarachidia*" *disgrega* also belongs here.

Tympanally speaking the other genera represent more or less isolated modifications of the general Erastrine type. *Amyna* (fig. 123), if not an Acronyctine, must be derived from the third group. It has a curious fifth pocket overlying pocket II (this will be discussed later in the morphological section). *Cydosia* (fig. 124) is a true Erastrine not greatly different from *Cobubatha*. *Grotelliforma* (fig. 125) is an extremely modified form which has no hood and no nodular sclerite (scutal phragma torn away in dissection); pockets I, II and III rather normal, but the air sac very intimately fused with pocket IV and separated from its posterior wall so that we find a shallow wall representing the dorsal and posterior portion of pocket IV, covered but distinct from the air sac which is fused with the antero-ventral wall (compare the Lithosiids). *Homolagoa* (fig. 126) is much like the third group. *Oruza* (fig. 127), *Phobolosia* (fig. 128) and *Phoenicophanta* (fig. 129) are separate modifications near the first group. And *Xanthoptera* (fig. 130) is an extremely modified form related to the first and second groups.

Tarachini: A very homogeneous group which might be made to include the third group of Erastrini. The alula is enlarged into a strongly chitinized, flap-like structure which conceals most of the tympanal membrane; and the hood is rudimentary or absent. This group includes *Conacontia*, *Conochares*, *Fruva*, *Graeperia*, *Heliocontia*, *Hemispragueia*, *Neptunia*, *Paracretonia*, *Spragueia*, *Tarache* and *Tarachidia* (fig. 131). The internal structures are the same throughout and almost identical with the third group of Erastrini (*Chamyris*, etc.), and very close to certain trifids. Pocket I is deep and almost closed; II deep, overlapping the base of III and reaching the corner of the tergo-pleural suture of the first abdominal segment; III also deep and intimately fused with the tympanal air sac; IV as shown. The scutal phragma is very small (not true for the third group of Erastrini) and the nodular sclerite weak.

North American Forms Examined

<i>Amiana niana</i> Dyar	<i>Hemispragueia idella</i> Barnes
<i>Amyna bullula</i> Grt.	<i>Homolagoa grotelliformis</i> B. & McD.
<i>Capis curvata</i> Grt.	
<i>Cerathosia tricolor</i> Sm.	<i>Lithacodia albidula</i> Gn.
<i>Chamyris cerintha</i> Treit.	" <i>caduca</i> Grt.
<i>Cobubatha quadrifera</i> Zell.	" <i>carneola</i> Gn.
<i>Conacontia augustipennis</i> Grt.	<i>Neotarache deserticola</i> B. & Benj.
<i>Conochares arizonae</i> Hy. Edw.	
<i>Cydosia nobilitella</i> Cram.	<i>Neptunia pulchra</i> B. & McD.
<i>Diastema tigris</i> Gn.	<i>Oruza albocostaliata</i> Pack.
<i>Erastria dividua opipara</i> Hy. Edw.	<i>Ozarba aerea</i> Grt.
	<i>Paracretonia aleptivoides</i> B. & McD.
<i>Erastrides propera</i> Grt.	
<i>Euaontia clarki</i> B. & McD.	<i>Phobolusia anfracta</i> Hy. Edw.
<i>Eublemma minima</i> Gn.	<i>Phoenicophanta bicolor</i> B. & McD.
" <i>obliquialis</i> Fabr.	
<i>Exyra semicrocea</i> Gn.	<i>Sexserrata hamponsi</i> B. & Benj.
<i>Fruva fasciatella</i> Grt.	<i>Spragueia dama</i> Gn.
<i>Graeperia sutrix</i> Grt.	<i>Tarache aprica</i> Hbn.
<i>Grotelliforma lactea</i> Stretch.	<i>Tarachidia candefacta</i> Hbn.
<i>Heliocontia apicella</i> Grt.	* <i>Xanthoptera nigrofimbria</i> Gn.

ACONTIINAE

This subfamily is closely related to and combines the characters of both tribes of Erastrinae. The alula may be small and unmodified (*Hylophila* & *Sinna*), or large and unchitinized (*Gabala*), or almost as heavily chitinized as in the Tarachini (*Earias*). The hood may be normal, rudimentary or entirely absent; metascutel-

lum broad and low; pockets various, but undoubtedly modified from the higher Erastrinae.

Earias (fig. 134) has pocket II turned backwards, so to speak, as in *Characoma* and *Sarrothripus* (closure at distal end and subsequent migration of mouth? Compare *Menopsimus*); III and IV as in the higher Erastrinae in all forms. The anterior end of the tympanal air sac is sufficiently chitinized to remain as an accessory anterior pocket in potashed specimens; this is very common in the trifids and is also found in certain other forms. *Hylophila* (fig. 135) has pockets I and II more normal and the hood membranous. *Gabala* and *Sinna* (fig. 136) are merely somewhat reduced forms. *Gabala* has a large alula and no hood; *Sinna* has a small alula and a small hood.

The American genus *Bagisara* (fig. 137) has been moved to the Acontiinae by Heinrich¹⁸ on a basis of the caterpillar and M_2 of the hind wing. The Acontiines and higher Erastrinae generally are so similar to the Aeronyetiinae in tympanal structure that I would not like to commit myself on the point. Suffice it to say that the tympanum, while somewhat different from the European Acontiines, is nevertheless closer to these than to any other form examined except *Ipimorpha*. The tympanum of *Ipimorpha* is almost identical with that of *Bagisara*, and Dr. Forbes says that the caterpillar also looks Acontiine.

Forms Examined

<i>Earias chlorana</i> L.	<i>Sinna extrema</i> Wlk.
“ <i>vernana</i> Hbn.	
<i>Gabala argentata</i> Butl.	<i>Bagisara subusta</i> Hbn.
<i>Hylophila bicolorana</i> Poda	<i>Ipimorpha pleonectusa</i> Grt.

SARROTHRIPINAE

Closely related to the last family of which it is placed as a derivative by Hampson. Metascutellum low and either broad, narrow or pointed; hood usually well developed, sub-dorsal and pointed; alula small and unmodified. Internal features about as in the Acontiinae.

In *Baileya* (fig. 138) the hood is small, but strongly chitinized and pointed; pockets I and II normal; III greatly expanded and fused with the air sac; IV conical as in the Erastrinae. *Casandria* (fig. 139) has a smaller hood with the spiracle ventro-anterior to

¹⁸ In Bottimer, L. J., Notes on some Lepidoptera from eastern Texas. Journ. Agr. Research 33 (9), p. 799. 1926.

it; pockets I, II and III reduced; III not fused with the air sac; IV typically Sarrothripine with a chitinous extension along the inner wall of the air sac towards pocket I. *Characoma* (fig. 140) has the entire air sac strongly chitinized with a heavy bar connecting the anterior end of pocket I to pocket IV along the medial wall of the air sac; pocket II as in *Earias*; III fused to the air sac and opening into IV; anterior end of the tympanal air sac strongly chitinized. *Sarrothripus* (fig. 141) is a continuation of the same scheme with the fusion more advanced; pockets I and II as in *Earias*, but III and IV intimately fused, the small dotted triangle in the figure representing the wall between pockets III and IV. The hood is small and membranous in both *Characoma* and *Sarrothripus*.

The palearctic genera *Blenina* and *Gadirtha* resemble *Hylophila*, whereas the nearctic genera are more like *Earias*. The neotropical *Stictothripa* (fig. 142) is somewhat different; pocket II is large, long and fused with the medial wall of the air sac, and in this process pockets II and III have become united. It is, however, distinctly Sarrothripine.

Forms Examined

* <i>Baileya ophthalmica</i> Gn.	<i>Blenina senex</i> Butl.
<i>Casandria abseuzalis</i> Wlk.	<i>Elisma narcissus</i> Cram.
<i>Characoma nilotica</i> Rogenh.	<i>Gadirtha inexacta</i> Wlk.
<i>Sarrothripus lintnerana</i> Speyer.	<i>Stictothripa albescens</i> Dgn.

PANTHEINAE

A small and extremely homogeneous group of hairy-eyed quadrids. Their relation to the other subfamilies is more obscure than that of any other group. They have the general appearance of the Acronyeta group of Acronyetinae, but have a highly modified caterpillar and an equally isolated tympanum. The tympanum might be considered an extreme modification from the trifids or Erastrinae or even from the Erebinae, but is too aberrant for more than a mere guess (compare *Noropsis*, fig. 103 and *Aon*, fig. 112).

The metascutellum is moderately narrow; the hood never well developed and as a rule entirely absent, fig. 2; the alula small and unmodified. Pocket II reaches the corner of the tergo-pleural suture of the first abdominal segment, and covers pocket III when that pocket is present; pocket IV conical and fused with the tympanal air sac.

All the forms examined are almost identical in tympanal structure (fig. 132) except that there is a very small hood in *P. palata*,

Charadra and *Colocasias*, and that pocket III is smaller in most genera and entirely lost in *Bathyra*, *Lichnoptera* and *Raphia* (fig. 133).

Forms Examined

<i>Bathyra sagata</i> Wlk.	<i>Panthea coenobita</i> Esp.
<i>Charadra deridens</i> Gn.	“ <i>furcilla</i> Pack.
<i>Colocasias propinquilinea</i> Grt.	“ <i>palata</i> Grt.
<i>Lichnoptera cavillator</i> Wlk.	<i>Raphia abrupta</i> Grt.
* <i>Raphia frater</i> Grt.	

THE TRIFID SUBFAMILIES

The trifold subfamilies have not been as thoroughly examined as the quadrifold ones, but they seem more homogeneous in tympanal structure, and the typical forms not greatly different from the higher *Erastrinae*.

Metascutellum broad and either high or moderately low; hood moderate, never greatly enlarged; alula normal; counter tympanal cavities larger than in the quadrifolds except for certain *Erastrinae*. Internal features of typical forms about as in the higher *Erastrinae*.

Achatodes, *Balsa*, *Brotolomia*, *Gortyna*, *Laphygma* and *Trachea* (fig. 143) are all much alike and very similar to the higher *Erastrinae*. *Acronycta* (fig. 145) is considerably different, but *Amphipyra* is only slightly modified (reduced pockets).

The genera examined of the *Cucullinae*, *Poliinae* and *Agrotinae* are all almost identical (fig. 144) and even more like the higher *Erastrinae* type than the *Acronyctinae* (except *Atethmia*, which is like *Trachea*). Pocket I overlaps and connects with IV; II overlaps III a long distance, and III is fused with the air sac.

Forms Examined

Acronyctinae

Achatodes zeae Harris
Amphipyra pyramidoides Gn.
Acronycta americana Harris
Balsa malana Fitch.
Gortyna nictitans americana
 Spey.
Laphygma frugiperda A. & S.
Phlogophora iris Gn.
 **Septis* (= *Trachea*) *arctica*
 Bvd.

Sidemia devastator Brace

Cucullinae

Atethmia pampina Gn.
Cucullia asteroides Gn.

Poliinae

Cirphis unipuncta Haw.
Nephelodes emmedonia Cram.
Neuria procincta Grt.

Agrotinae

Feltia herilis Grt.
Graphiphora c-nigrum L.
Heliothis virescens Fabr.

VI. EXOTIC NOCTUIDAE

In addition to the exotic genera specifically treated in the text a number of others have been examined. These represent so small and scattering a percentage of the world fauna that it does not seem advisable to discuss them in detail. Suffice it to say that they do not appear to invalidate any of the statements made in this paper.

Representatives of the small subfamilies have been treated along with the American forms in the text and a few exotic Erebines are also included in that section. Names preceded by a dagger (†) are commented on in the appropriate section of the text.

Hermiiniinae

- Amilaga albiapicata* Holl.
Asthalia silenusalis Wlk.
Bocana manifestalis Wlk.
Echanella albobasalis Holl.
Edessena hamada Fldr.
 "Epizeuxis" crucialis Fldr.
Hadennia emmolodes Beth-Bak.
 †*Herminia tentacularia* L.
Hydrillodes toresalis Wlk.
Nodaria externalis Gn.
Oraenamias brontesalis Wlk.
 †*Paraherminia derivalis* Hbn.
 †*Pseudaglossa albomaculata*
 Leech
Simplicia schalousalis tribinia
 Beth-Bak.
Systaticospera orphnina
 Beth-Bak.
Zanclognatha cribralis Hbn.

Rivulinae

- †*Hyenodes albistrigalis* Haw.
 †*Madopa salicalis* Schiff.
Mosopia eudoxusalis Wlk.
Ostha centripomens Dyar
 †*Parascotia fuliginaria* L.
 †*Prosoparia tenebrosa* Schs.
 †*Stellidia vanata* Schs.
Tholomiges turfosalis Wlk.

Hypeninae

- †*Aglaonice snelleni* Moesch.
Anoratha costalis sinuosa
 Wilem.
 †*Aventia flexula* Schiff.

- Bertula similalis* Swinh.
Catada renalis Moore
Dichromia leucotaenia Snell
 " tripicalis Wlk.
Euphiuche apoblepta Turner.
Harita rectilinea Moore
Osericana molybdaenis Hmps.
Rhynchina abducalis Wlk.
Rhynchodontodes antiqualis
 Hbn.

Erebine-Catocaline Complex

- Achaea echo* Wlk.
 " indeterminata Wlk.
 " mormoides Wlk.
 " sp. ?
Apopestes cataphanes Hbn.
 †*Arcte papuensis* Warr.
Arsaciodes rufa Schs.
Audea bipunctata Wlk.
Baputa dichroa Narsch.
Blosyris buteo Gn.
 " phianassa Cram.
 " scops Gn.
 " scopsella Hmps.
Cosmophila fulminans
 Beth-Bak.
Cycligramma latona Cram.
Deinhypena lacista Holl.
Homodes propitia Gn.
Latebraria janthinula Gn.
 †*Leucanitis picta* Christ.
Lineopalpa horsfieldi Gn.
Lopharthrum comprimens Wlk.
Masca abactalis Wlk.

† <i>Mazacyla relata</i> Wlk.	<i>Spieredonia retorta</i> L.
<i>Mursa phtisialis</i> Gn.	<i>Sypna achaeopsis</i> Prout
<i>Oxyodes scabiculata</i> Fabr.	† <i>Teinonomis sergilis</i> Stoll
† <i>Parachabora abydas</i> H.-S.	† <i>Thysania agrippina</i> Cram.
<i>Parallelia algira</i> L.	Erastrinae
† <i>Pararcte schneideriana</i> Cram.	†“ <i>Tarachidia</i> ” <i>disgrega</i> Mösch.
<i>Rhododactyla semirosea</i> H.-S.	Acronyctinae
<i>Sarrothrocerus alluaudi</i> Mab. ¹⁹	† <i>Diloba caeruleocephala</i> L.
<i>Sosxetra grata</i> Wlk. ²⁰	

Graphelysia strigillata Roths.²¹

VII. OTHER NOCTUOID FAMILIES

Dioptidae: Because of their especial interest as the most primitive Noctuid family, this group is also treated under the morphological section. The metascutellum is broad and usually low; no hood and no nodular sclerite, and the tympanal and counter tympanal membranes small. The epimeron is concave so that the tympanal membrane faces ventrally, and a chitinous prong from the epimeron reaching towards the anterior end of pocket I serves as a support for this membrane. The subalar sclerite is well developed and reaches the anterior end of pocket I; the scutal phragma is large and high up on the scutum (compare the Notodontids). Pockets I and II are represented by the basal ridge only; III absent, and IV far ventral and only slightly developed.

Myonia (fig. 152) is easily understood from the family description. *Phryganidia* is fundamentally the same but reduced, however *Cyanotricha* and *Josia* (fig. 153) have a more highly developed organ. Also these last two genera have a peculiar outside pocket not seen elsewhere (see under next section). Incidentally *Cyanotricha* and *Josia* show the secondary subdivision of the epimeron into two sclerites whereas the first two genera do not.

¹⁹ Classed by Seitz as a Hypsid, but has a typical Erebine tympanum with a single pocket IV about as in figure 47.

²⁰ An aberrant quadrid genus with the tympanum of a trid (fig. 105).

²¹ This species was described as an Arctiid; later moved to the Acontiinae by Forbes (1924), and then placed in the Hypsids by Seitz. It has the postspiracular hood of the Noctuidae, but its internal features present one difficulty (fig. 106). Pockets I, II and III will fit in in any number of places and accordingly give us no clues, but pocket IV is of the primitive type found in the Hypsids-Arctiids but very rare in the Noctuidae above the Rivulinae. (Only in *Plusiodonta* and the *Cryphia* group).

The neotropical *Cyanohypsa* (fig. 154) has a hopelessly aberrant tympanum. The metascutellum is very high; the hood, nodular sclerite and scutal phragma absent; the tympanal membrane small and facing ventrally with the margin of the epimeron reaching the anterior end of pocket I. Pocket I rudimentary; II very long and well developed; III and IV entirely absent. This genus has a quadrifid fore wing, but a tympanum of the trifid series (fore wing). *Cyanohypsa* and *Thaumtopoea* were the only genera examined which had a tympanum and yet no trace of the anterior wall of pocket IV (dorsal border of epimeron represents the posterior wall, but the anterior wall lacking).

Notodontidae: All the genera examined have the same tympanal structure (fig. 155). The metascutellum is high; the hood and nodular sclerite absent; the scutal phragma high, and the epimeron concave with the tympanal membrane facing ventrally as in the Dioptidae. Pockets I and II very small; III absent; IV supporting the concave epimeron from below. The tympanal air sac is somewhat more fused with the frame than in the Dioptidae.

Thaumtopoeidae: As in the Notodontidae except that pocket IV is absent.

The American genus *Doa* (fig. 156) is a connecting link between the trifid and quadrifid families. It has no hood, no nodular sclerite, and a moderately sunken tympanal region as in the trifid families, but a well developed pocket III and a scutal phragma as in the quadrifid families. Incidentally the counter tympanal membrane is heavily and uniformly chitinized.

Hypsidæ and Pericopidae: Simultaneous with the change from families with a trifid fore wing to ones with a quadrifid fore wing a number of changes are found in the tympanum. These are: the development of the hood (prespiracular), the nodular sclerite and pocket III; the flattening out of the tympanal region, and the modification of the scutal phragma into its definitive form.

These changes are shown in figure 158 which also shows the low metascutellum; the very slightly sunken tympanal region; pocket I and II well formed but small, III large and free, and IV still of the primitive ventral brace type.

Lymantriidae: Differs from the last only in that the tympanal region has become completely flattened and that pocket III is intimately fused with the air sac (fig. 159). The wingless female of *Hemerocampa* has a vestigial tympanum, but the male has a normal one as in *Porthetria*.

The Japanese genus *Camptoloma* (fig. 157) is quite unique. The hood is absent; the scutal phragma and nodular sclerite are normal as are also pockets I, II and IV, but pocket III is enormous and like nothing else seen (that is if this pocket is really homologous with the pocket III of other forms).

Arctiidae: Tympanally identical with the Pericopids (fig. 158) except that the hood is smaller and frequently pointed.

Syntomidae: Fundamentally the same as in the Pericopids and Arctiids. In *Ctenucha* (fig. 160) and *Scepsis* pocket III has fused more intimately with the air sac. *Scepsis* differs from *Ctenucha* in having a larger nodular sclerite and pockets III and IV somewhat shorter.

The palaearctic genus *Syntomis* has no hood and no nodular sclerite; a large counter tympanal membrane but only a very small tympanal membrane, and a frame in which all the pockets have become vestigial. Eggers (1919) has already noted this and queried its functional capacity.

Lithosiidae: This family has a greatly reduced tympanum, but shows considerable variation among its genera. There is no hood and no nodular sclerite, and the pockets are greatly reduced. They may be distinguished from reduced Erastrinae only by pocket IV which is double and primitive here, but single and usually fused with the air sac in the Erastrinae.

Crambidia (fig. 150) shows this reduction towards a mere stress-line frame. Pocket III is the only one which is well developed. *Hypoprepia* (fig. 149) has small pockets I and II, but III and IV even more reduced than in *Crambidia*. The tympanum of the peculiar neotropical *Gardinia* is also of this type.

Agaristidae: *Alypia* (fig. 146) is much like the Acronyctinae, but the counter tympanum is greatly enlarged and the counter tympanal membrane several times the size of the tympanal membrane (see Eggers 1919, fig. 19). Following Seitz I am treating *Euthisanotia* (fig. 147) and *Psychomorpha* (fig. 148) here; both have extremely modified tympanal frames not encountered elsewhere. All three genera have enlarged counter tympanal membranes and no hood.

Nolidae: Tympanally (fig. 151) not at all like the Arctiid series, but very close to the Erastrinae. The metascutellum is low, and the hood membranous and completely dorsal to the spiracle so that it is impossible to state for certain whether it is pre- or postspiracular. Pocket IV is single and fused with the air sac wall as in the Erastrinae.

Forms Examined

Dioptidae

Cyanotricha bellona Dru.
Josia auriflua Wlk.
Myonia cingulina Dyar
Phryganidia californica Pack.

.....
Cyanohypsa stephanelli
 Giacomelli

Notodontidae

Datana angusi G. & R.
Heterocampa guttivitta Wlk.
Ichthyura inclusa Hbn.
Malocampa n. sp. near *sorex*
 Schs.

Rosema zelica Stoll

Thaumatopeidae

Thaumatopea pityocampa
 Schiff.

.....
Doa ampla Grt.

Hypsidae-Pericopidae

Gnophaela vermiculata G. & R.
Hypsa caricae L.

Lymantriidae

**Hemerocampa leucostigma*
 A. & B.

Porthetria dispar L.

.....
Desmoloma mollis Dyar

Arctiidae

Estigmene acraea Dru.
Halisidota caryae Harris

Syntomidae

Ctenucha virginica Charp.
Scepsis fulvicollis Hbn.
Syntomis phegea L.

Lithosiidae

Afrida claricosta Dyar
 "Chrysocale" (*Gardinia*)
magnifica Wlk.

Crambidia pallida Pack.

Hypoprepia miniata Kirby

Agaristidae

Alypia octomaculata Fabr.
Euthisanotia grata Fabr.
Psychomorpha epimenis Dru.

Nolidae

Celama triquetrana Fitch
Roeselia minuscula Zell.

.....
Camptoloma interiorata Wlk.

VIII. MORPHOLOGICAL HOMOLOGIES IN THE TYMPANAL REGION

By a comparison of the thoracic structure of representatives of certain families which lack a tympanum²² with the Dioptidae, *Cyanohypsa* and certain other primitive forms we can draw sclerite homologies with fair safety.²³

In forms which lack a tympanum (fig. 161) the heavy posterior border of the epimeron becomes dorsally the epimero-postnotal suture and reaches the lateral extremity of the scutellum, thence curving ventrally and later dorsally in a wide semicircle to reach

²² *Sthenopsis quadriguttatus* Grt., *Pholus pandorus* Hbn., *Yponomeuta multipunctella* Clem., *Anisota rubicunda* Fabr., and *Malacosoma americana* Fabr.

²³ It seems superfluous to point out that the modifications brought about by the introduction of the tympanal air sac deprive us of any data ordinarily obtainable from muscle attachments.

the base of the wing at the epimero-episternal suture. In the membranous semicircle below the wing lies the large subalar sclerite with its posterior prong almost reaching the point of junction of the epimeron and scutellum. The postnotum is an oval, infolded sclerite which needs very little change to become the counter tympanum. From the medial corner of the postnotum the tergo-pleural suture of the first abdominal segment extends posteriorly as a brace. In some forms (*i.e.*, *Yponomeuta*) there is even a small scutal phragma a short ways up on the scutum.

The Diopiid genus *Myonia* (figs. 152 and 162) has a very primitive tympanum, and shows the first steps in the development of this organ. As usual the posterior part of the dorsal margin of the epimeron is a strong ridge joining ventrally with the border of the furcisternite. Below its junction with the postnotum this border gives off a small ridge anteriorly onto the main body of the epimeron. The entire region has become extremely concave, and is braced from below by the margin of the epimeron and especially by this new ridge which has just developed. This secondary ridge becomes the anterior wall of pocket IV, the margin of the epimeron forming the posterior wall of this double pocket. Further dorsally the margin of the epimeron becomes the epimero-postnotal suture, and stands out as an internal ridge which represents the boundary between (common base of) pockets I and II. Further anteriorly just posterior to the subalar membranization, the epimeron has a dorsal prong reaching towards the anterior end of pocket I and thereby delimiting the tympanal membrane. Due to the concavity of the epimeron the tympanal membrane faces diagonally ventral. The large subalar sclerite reaches posteriorly to the anterior end of pocket I, and even seems to articulate with it. Just dorsal to the subalar sclerite is the axillary cord, and just above that the ventral margin of the scutum. From well up on the scutum there is a large scutal phragma which braces the tympanal air sac dorsally. A small counter tympanal membrane completes the picture.

This condition, with certain idiosyncrasies, holds fairly well for all the families with a trifold fore wing. In the peculiar genus *Doa* (figs. 156 and 163) we have the transition to the quadrifid series type. There is still no hood and no nodular sclerite, but there is a full-fledged pocket III bracing the main stress-line (epimero-postnotal suture) to the tergo-pleural suture of the first abdominal segment, and a scutal phragma of the "higher" type.

Then there is an abrupt jump from *Doa* to the Hyspids (fig. 158) where the tympanal concavity has flattened out almost com-

pletely with a consequent distortion of the frame; the pockets are all fully formed, and the hood and nodular sclerite have appeared. From the Hypsids to the higher Noctuids (fig. 164) the only fundamental change is in the fusion of the anterior and posterior walls of pocket IV; other changes are merely developments along lines already present.

Summarizing this by the structures involved rather than by the representative forms we arrive at the following conclusions (plate 19): The dorsal and posterior border of the epimeron is that shown by the heavy line in figures 161-164. It extends as a heavy band dorsally from the furcisternite to the end of the scutellum (being paralleled for part of the distance by the postnotum) and then makes a semicircle ventrally to reach the wing base. The posterior half of this border is the main brace of the region, and with the development of the tympanum becomes even heavier and stands out internally as a ridge. Ventral to the point where this suture reaches the postnotum a ridge develops anteriorly onto the epimeron as a ventral brace to the tympanal concavity. This ridge comes to form the anterior wall of pocket IV; the margin of the epimeron just dorsal to it forming the posterior wall of this double pocket. This suture then passes along the posterior margin of the tympanal membrane to the end of the scutellum. Once dorsal to the membrane it stands out as an internal ridge, and from its inner margin a slight chitinous wall develops anteriorly onto the epimeron to form pocket I, and posteriorly into the postnotum to form pocket II. Pocket III when first found is already well developed. It lies on the postnotal side of this suture, and its base serves as a cross-brace from the tympanal membrane to the tergo-pleural suture of the first abdominal segment and less as a support for the counter tympanal membrane. This interpretation means that pockets I and IV are epimeral, whereas pockets II and III are postnotal.

The main portion of the postnotum is very slightly altered. There is already an oval, lightly chitinized area in this sclerite, and apparently this becomes the counter tympanal membrane directly by fusion with the tracheal air sac wall. The ventral border of the postnotum gives rise to pockets II and III.

From the peak at the dorsal end of the base of pockets I and II the margin of the epimeron extends diagonally ventral to the anterior end of pocket I, and is joined there by the posterior end of the subalar sclerite. It passes ventrally, presumably represented by the nodular sclerite, to the suture dividing the epimeron into the preepimeron and epimeron proper (when that is present), and

thence curving dorsally to the wing base. Apparently the epimeral prong bounding the anterior side of the tympanal membrane in the trifid families becomes detached as the nodular sclerite when the tympanal concavity flattens.

The subalar sclerite articulates to the anterior end of pocket I, and in higher forms is represented by the narrow, chitinized rod extending anteriorly from pocket I just ventral to the axillary cord. Immediately dorsal to the axillary cord is the ventral edge of the scutum. In the trifid families there is a scutal phragma extending inwards from about two-thirds the way down the scutum. This becomes the dorsal brace of the tympanal air sac ("Spannleiste" of Eggers), and in the quadrifid families that part of the scutum ventral to the phragma is reduced to a very narrow strip. The phragma ends posteriorly at the ventral end of the scutellum just dorsal to the base of pockets I and II, and reaches anteriorly towards the wing base.

When the tympanum first develops the epimero-postnotal suture is almost straight and the epimeron concave, with the tympanal membrane facing ventrally (see any Notodontid). In the quadrifid series this region becomes flush with the rest of the thoracic wall. Seemingly the "strain" produced by this change is the cause of the epimero-postnotal suture becoming so contorted.

According to this view the tympanal frame has a double origin; that part containing pockets I and II being epimeral, whereas that part containing pockets II and III is postnotal. The counter tympanal membrane is postnotal; the dorsal brace of the tympanal air sac is a scutal phragma; the chitinous rod extending anteriorly from pocket I is the subalar sclerite; the nodular sclerite is a detached prong of the epimeron; the "accessory" or "false" tympanal membrane is the usual membranous area of this region, and the tympanal membrane may be either a part of this or more likely a secondary membranization of the epimeron.

If one likes the "stress and strain" hypotheses used in studies of the vertebrate skeleton, he can account for the fundamentals of all the complex parts of the tympanal frame with their aid.

A few other points should also be mentioned here. In *Amyna bullula* (fig. 123) the common base of pockets I and II has developed medially beyond the wall of these pockets, and subsequently another chitinous wall has developed posteriorly from its inner edge to give a "pocket V" lying over (medial to) the base of pocket II. This is additional positive evidence of the method of formation of pockets I and II. *Cyanohypsa* (fig. 154) is very aberrant. Seem-

ingly it possesses a functionally well developed tympanum, but there is no trace of the anterior wall of pocket IV, and pocket II is very deep, but pocket I rudimentary (of course no pocket III). *Thaumtopoea* also lacks the anterior wall of pocket IV. And finally in *Cyanotricha* and *Josia* (fig. 153) the tympanal concavity has been largely cut off from the exterior by the development around it of chitinous walls from its border. This results in a large kettle-drum structure with the tympanal membrane at its dorsal end and a relatively small opening to the outside indicated by a dotted line in figure 153.

IX. DISCUSSION AND CONCLUSIONS

GENERAL EVALUATION OF THE TYMPANAL CHARACTERS

The *hood* is found only in those families with a quadrid fore wing, and even then is sporadically absent, though rarely so for entire groups (*Lithosiidae* and *Pantheinae*). It may be either full, subdorsal or dorsal—that is the first abdominal spiracle is typically opposite the mouth of pocket III, and when the center of the hood coincides with the center of the tympanal membrane the spiracle is under the middle of the hood. However in many forms the hood is developed dorsally, and its center no longer coincides with the center of the tympanal membrane. Although still in the same relation to the tympanal frame the spiracle is then near the ventral edge of the hood of entirely below it (*Nolidae*). In some forms there is a small semimembranous lobe just ventral to the hood; this becomes the second hood of the *Stictopterinae* and *Plusiinae*. Also in many genera of the *Erebinae-Catocalinae* complex there is another chitinization of the pleuron posterior to the hood (fig. 5). The shape and position of the hood is occasionally useful in phylogeny, and when so is usually a group character. It has been outlined in the diagram as it lay in the preparation, and might be pulled forward or backward so that its absolute size must be used carefully if at all.

The *alula* is frequently enlarged, but in the *Tarachini* and a few *Acontiinae* is also heavily chitinized.

The *nodular sclerite* offers specific characters as a rule, but occasionally is generic and less often grouping (*Hypena* group, *Melipotis-Syneda* series).

The *shape of the tympanal membrane* seems of little aid though more use may be made of it in the future (see *Melipotis-Syneda* series).

The *scutal phragma* is alike throughout the families with a trifold fore wing, but in the quadrid families offers only specific characters as a rule. It has not been used in the grouping given in this paper.

The *counter tympanum* is occasionally enlarged and greatly so in the Agaristidae.

Pocket I is usually specific, but frequently offers grouping characters by pouches or an overhung margin.

Pocket II is extremely variable and must be used with care. Its asymmetry is a risky character since it varies greatly according to the angle from which it is being viewed. Occasionally it overlaps pocket III and thereby offers a useful character.

Pocket III usually offers good characters. Its relative proportions and the size of its mouth should be used with care, but the extent of fusion with the air sac and with pocket IV is better.

Pocket IV offers some of the best characters. It may be either single or double; sometimes fused with the tympanal air sac and less often with pocket III. In several groups there is a tendency for this pocket to be connected to pocket I by a line of chitinization along the median wall of the air sac. Frequently its size and shape serve excellently for linking genera.

As noted before an *epimeral bulge* ventral to the tympanal membrane may be of either of two types: it may be an enlarged pocket IV (Plusiinae), or the epimeron ventral to this pocket and having nothing to do with the tympanal region (Herminiinae, etc.).

A combination of all of these characters is naturally best, and no one is without exception. Without a doubt the accessory tympanal modifications frequently offer good characters for subfamilies, generic groups, genera, subgenera and even species. It must be emphasized however that there are slight differences caused by the angle of projection and by any rupture in the dissection. Characters especially affected by these factors have been given the least importance, and all specimens figured have been examined at least twice to minimize errors from this source.

No sexual dimorphism was noted even in such genera as *Palthis*, except for the wingless ♀ Lymantriids. Intraspecific variation is not common though a slight amount of difference in quantitative characters is usually observable (exact depth of pockets, length of projections, etc.). Intraspecific variation of a qualitative nature is exceedingly rare. In *Prosoparia*, as discussed in the text, there was great variation, but this was the only genus in which it was serious. In *Phiprosopus* and *Euclidia* (see in text) some of the

specimens examined differed from the normal type of the group, whereas the majority fitted in very well. I am not certain of the identification of the eastern species of *Gabara*, but a series of a dozen mounts representing four or five species varied between the limits shown by figures 41-43, half of these being almost or quite like figure 42. Series of specimens of certain species were examined periodically (species marked by an asterisk * in the lists), and all forms which for any reason seemed out of place were examined by series. However the general tendency was to do another species of the same genus on the questionable assumption that if two species were alike, then two specimens of the same species would probably be alike also. And so in conclusion on this important point we can say that a slight amount of quantitative variation is usually present, but that vast quantitative or qualitative variation is rare. Freaks are occasionally found, but they, like variation, are certainly no commoner and no more serious than in other characters such as venation and genitalia.

* * *

In all, 372 species representing 300 genera were examined. The majority of these were in the quadrifid Noctuidae, and of the genera of quadrifid Noctuids listed by Barnes & McDunnough from North America, *Eupseudomorpha* is an exotic Agaristid and *Agassizia* and *Homophoberia* are lost names; all the other North American quadrifid genera and most of the subgenera have been examined except *Argillophora*, *Homocerynea*, *Prorollemma* and *Trichotarache* (all *Erastrinae*). The other families and subfamilies were not studied as intensively, but it is obvious that the greatest variation is to be found among the quadrifid Noctuids. Species within a single genus were almost invariably alike except in the Erebine-Catocaline complex, and even there the genera tend to hold together.

The tympanal characters would indicate about the same family derivation as given by Forbes in the "Lepidoptera of New York and Neighboring States," and a slight modification of this is given on plate 20. *Doa* apparently is a connecting link between the families with a trifid fore wing and those with a quadrifid fore wing. But if we are to put much faith in these family trees it seems strange that a large series of quadrifid families should be derived from another quadrifid set via several small trifid families (note the scutal phragma in this connection).

The Nolidae have a caterpillar of the Aretiid series which, however, has lost a pair of prolegs; they make a peculiar little cocoon

like the Acontiinae and Sarrothripinae; Shepard (1930) reports some unique features in the thoracic sclerites, and in this paper the tympanum is shown to be of the Erastrine type. The Noctuid families, other than the Noctuidae, Agaristidae, Lithosiidae and Nolidae, are remarkably homogeneous throughout and not highly modified from the primitive type exemplified by *Doa* and the Hyspids. The greatest variation is found in the Noctuidae, and even here the subfamilies with a trifold hind wing have reached a rather stable type. The Lithosiids and certain Erastrines have converged greatly by reduction, but can always be separated by pocket IV.

On plate 20 is given a phylogenic scheme of the Noctuid genera based on the tympanum but considering other characters also. This may be read directly with the text and need not be discussed in this section. In a number of cases the tympanal characters definitely link otherwise isolated forms with well known groups (*Raphia*-Pantheine, *Menopsimus*-Rivuline, *Reabotis*-*Camptyllochila*, etc.). This phylogeny of the Noctuid subfamilies is substantially the same as that given by Hampson, but the Plusiinae which are otherwise isolated are connected with the Erebiniae via the Stictopterinae on the tympanum, and the Euteliinae show characters of both the Erebiniae and Erastrinae. The Pantheinae are unplaceable. The division of the Erebine-Catocaline complex on a basis of spined tibia is purely artificial as shown by such genera as *Arcte* and *Pararcte*, *Leucanitis* and *Syneda*, etc., etc. A tentative grouping on tympanal characters is given here: groups I, III and VI seem to be natural, but II is a conglomerate of forms which might be scattered among the others if so desired, and groups IV and V, which include the main mass of the subfamily, some might prefer to unite as far as the tympanum is concerned though they are distinct from the other groups and contain a number of rather vague subgroups of uncertain interrelationship.

X. SUMMARY

1. Short sections on literature and technique.
2. Thorough description of the region and the structure of the tympanal frame.
3. Systematic treatment of the tympanal modifications in the various families and subfamilies of the Noctuoidea with special emphasis on the quadrifid Noctuidae.
4. These modifications are discussed (as well as variation), and it is concluded that the accessory tympanal structures offer good

characters for generic and subfamily phylogeny. A tentative phylogeny of the quadrid Noctuids is presented (pl. 20).

5. Sclerite homologies and the probable origin of the complex structure are discussed. The tympanal membrane, the nodular sclerite and that part of the frame containing pockets I and IV are epimeral; the counter tympanal membrane and that part of the frame containing pockets II and III are postnotal; the dorsal brace of the tympanal air sac is a scutal phragma; the "accessory" tympanal membrane is the usual subalar membranization, and the chitinous rod extending anteriorly from pocket I is the subalar sclerite. It is possible to explain the origin of all of these parts on a "stress and strain" hypothesis (pl. 19).

XI. ACKNOWLEDGEMENTS

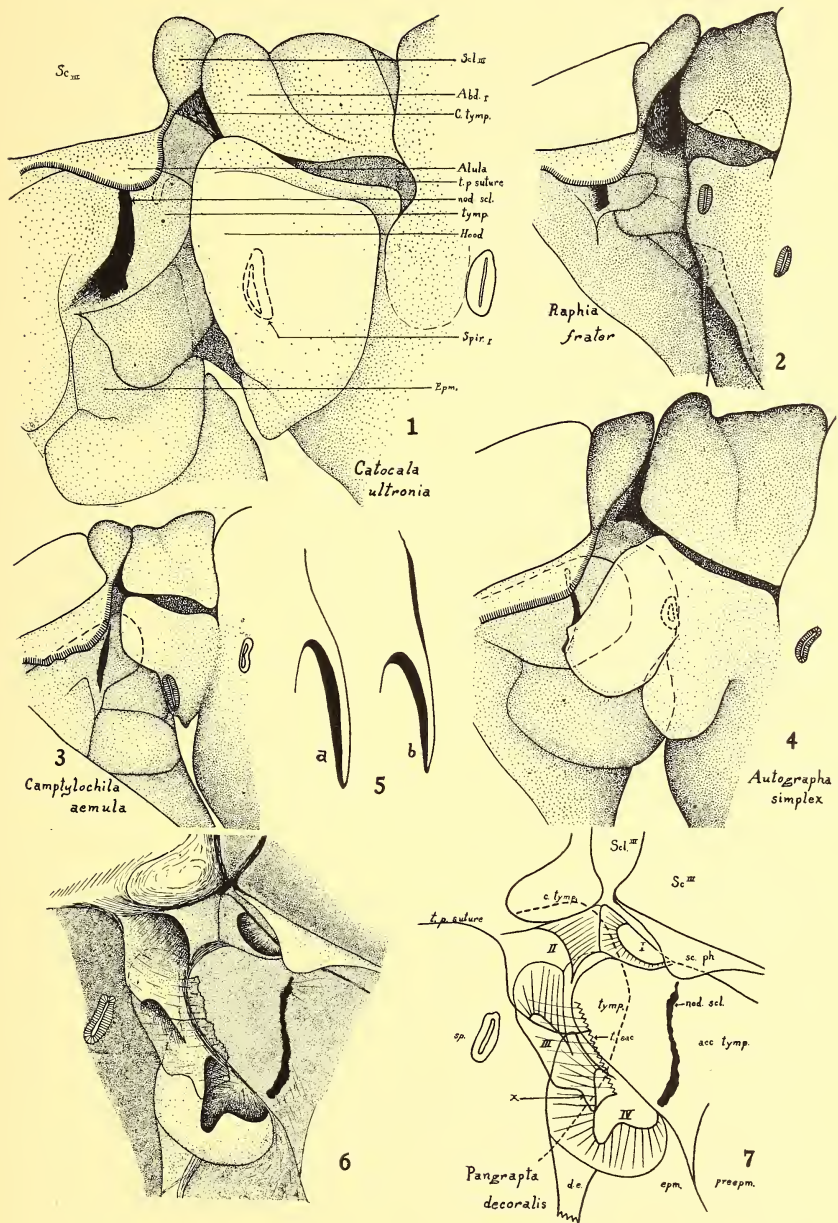
The author would like to express his indebtedness to the Cornell University Collection for much of the material studied; to the U. S. National Museum for the loan of eighteen forms otherwise unavailable; to Dr. A. E. Brower for the named specimens of *Catocala*, and to Miss A. E. Prout of the Hill Museum for quite a number of the old world genera.

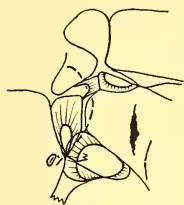
The author's greatest thanks are due to Dr. W. T. M. Forbes for suggesting the problem as a continuation of his own work and for his interest and help throughout.

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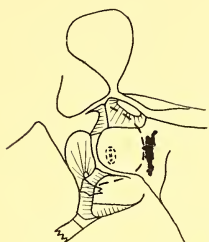
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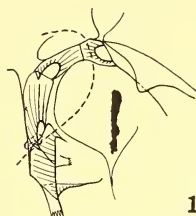
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Paraherminia
derivalis



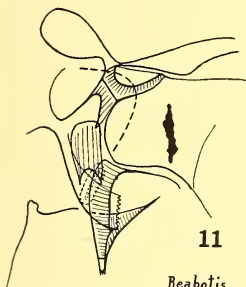
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Herminia
tentacularia



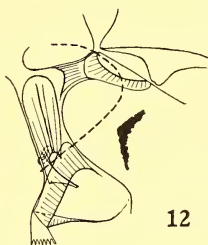
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Camptylorchila
aemula



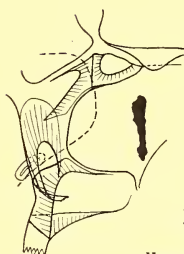
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Reabotis
immaculalis



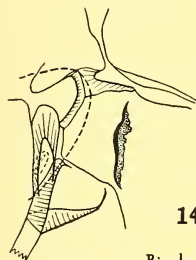
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Bleptina
caradrinalis



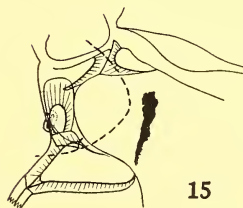
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Hormisa
absorptalis



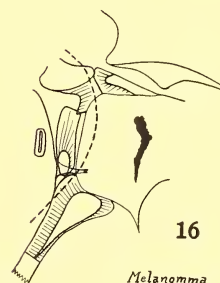
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Rivula
propinquialis



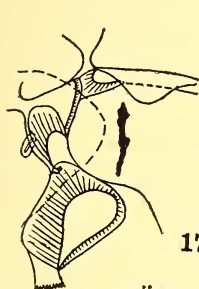
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Salia
interpuncta



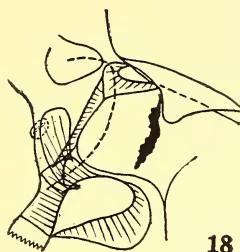
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Melanomma
auricinctaria



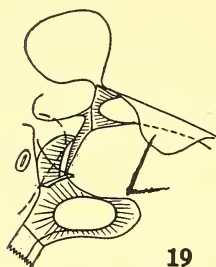
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Hypanopsis
macula



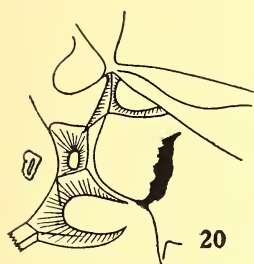
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Mycterophora
rubricans



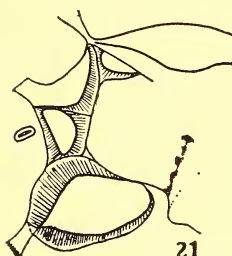
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M.
inexplicata



20

Parahypanodes
quadralis



21

Menopsimus
caducus



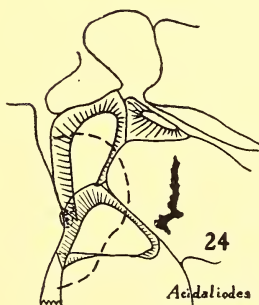
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Oxycilla
triplex



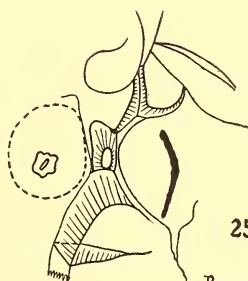
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Dyspyralis
illocata



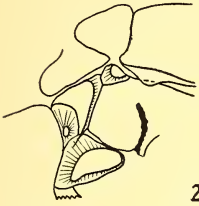
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Acidaliodes
flavipars



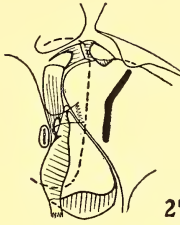
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Prosoparia
tenebrosa



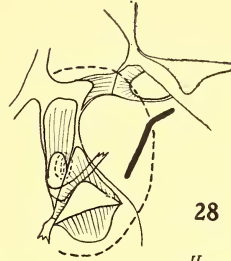
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Sigela
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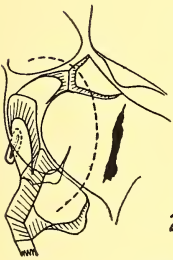
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Pleonectyptera
pyralis



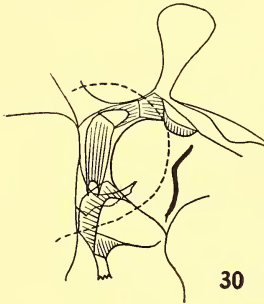
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Hypena
humuli



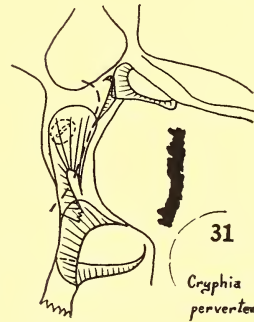
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Lomanaltes
eductalis



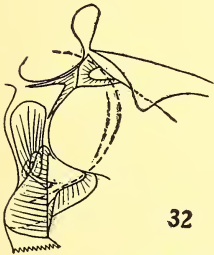
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Ommatochila
mundula



31

Cryphia
pervertens



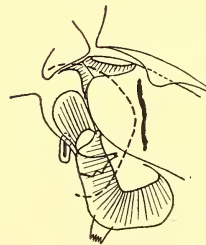
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Prothymia
semipurpurea



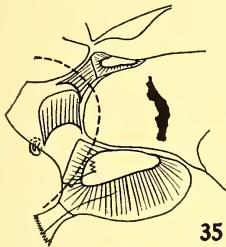
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Isogona
natalia



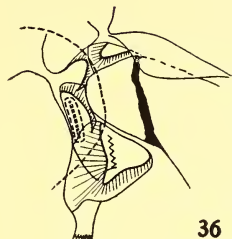
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Metalectra
discalis



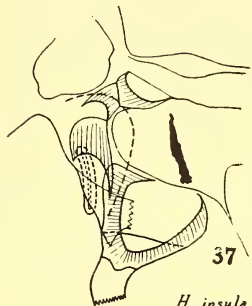
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Diallogma
latiorella



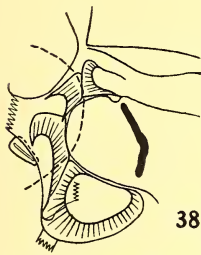
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Herminode
guttata



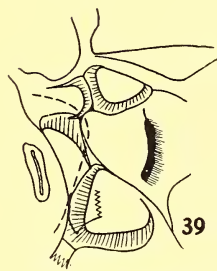
37

H. insula



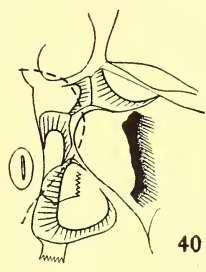
38

Scolecocampa
liburna



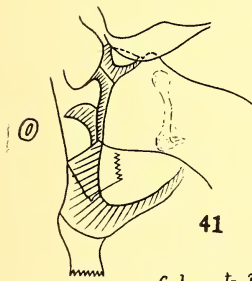
39

S. atriluna



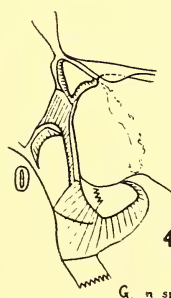
40

Gabara
obscura



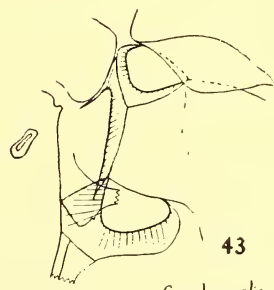
41

G. bipuncta ?



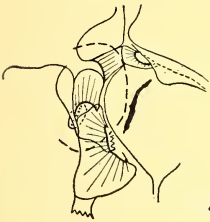
42

G. n. sp. ?
near pulverosalis

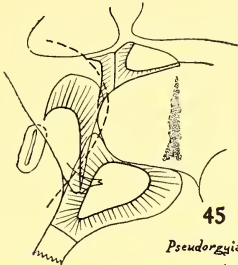


43

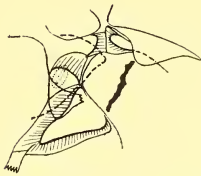
G. pulverosalis



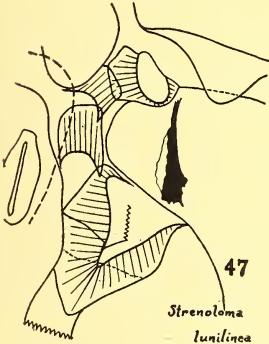
44
*Egrylan
filaria*



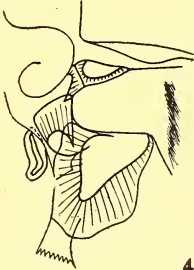
45
*Pseudorgyia
versula*



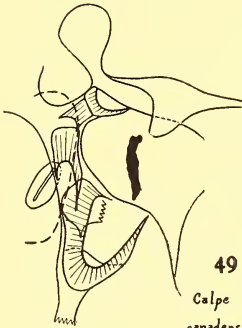
46
*Phiprosopus
callitrichoides*



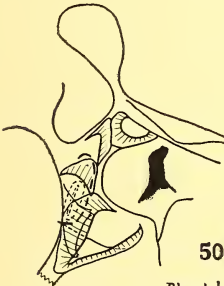
47
*Strenoloma
lunilinea*



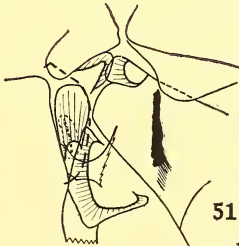
48
*Hypsoropha
monilis*



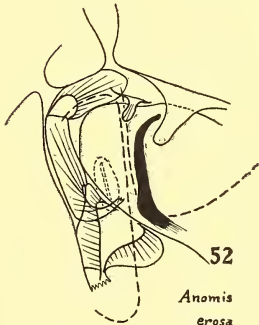
49
*Calpe
canadensis*



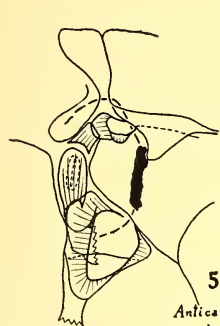
50
*Rhescipha
obtusa*



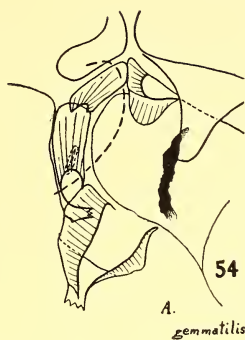
51
*Capnodes
placida*



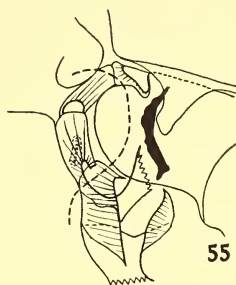
52
*Anomis
erosa*



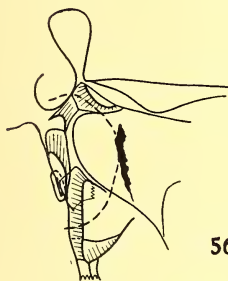
53
Anticarsia
schausi



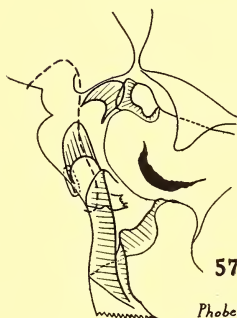
54
A.
gemmatilis



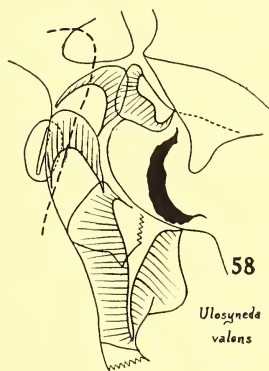
55
Antiblemma
inexacta



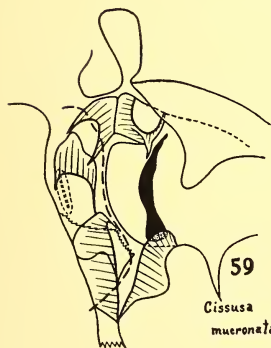
56
Plusiodonta
compressipalpis



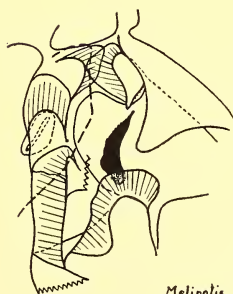
57
Phoberia
atomaria



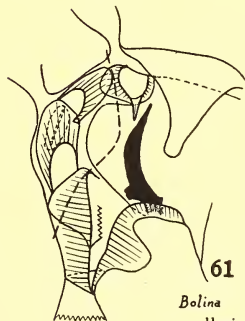
58
Ulosyneda
valens



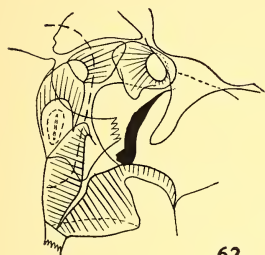
59
Cissusa
mucronata



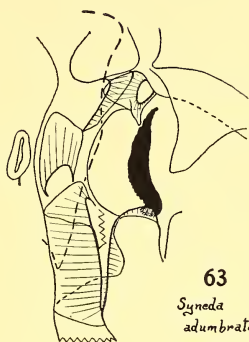
Melipolis
jucunda



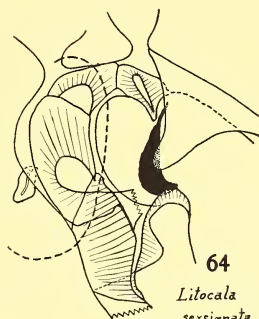
61
Bolina
cellaris



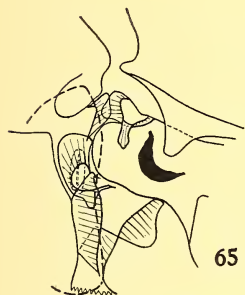
62
Cirrhopolina
mexicana



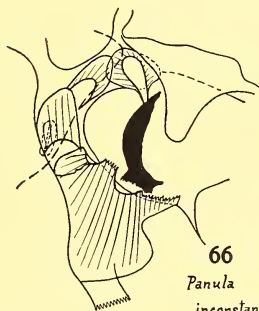
63
Syneda
adumbrata



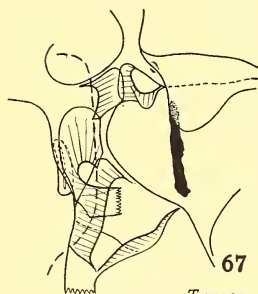
64
Litocala
sexsignata



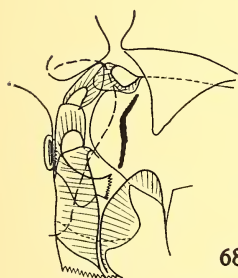
65
Hypocala
andremona



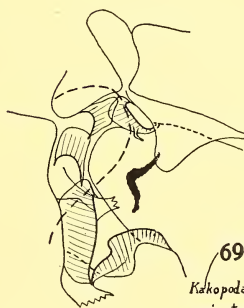
66
Panula
inconstans



67
Toxocampa
victoria



68
Trama
deltrahens



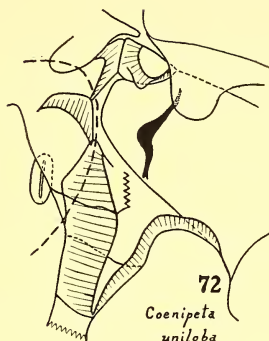
69
Kakopoda
cincta



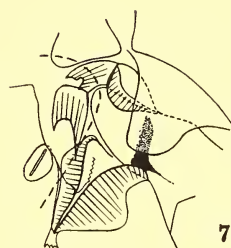
70
Yriasis
repentis



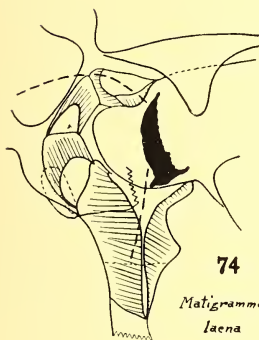
71
Heteranassa
minor



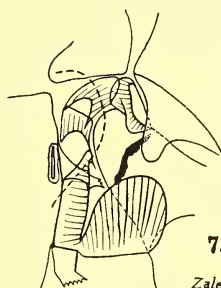
72
Coenipeta
uniloba



73
Euparthenos
nubilis



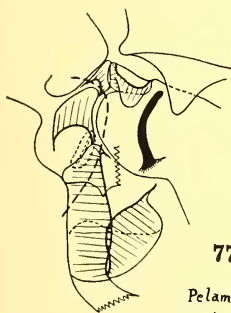
74
Matigramma
laena



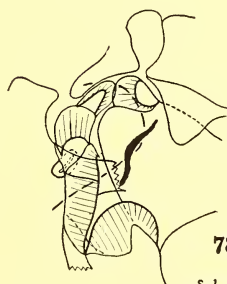
75
Zale
lunata



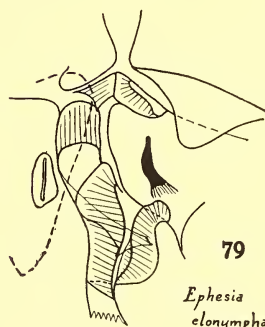
76
Zaleops
umbrina



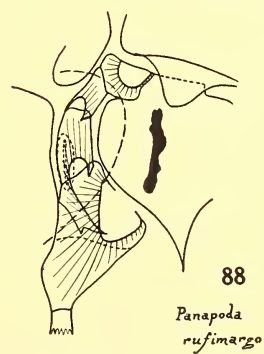
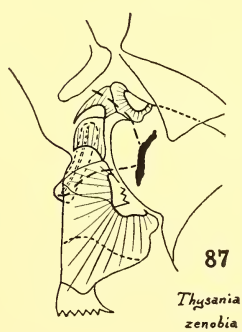
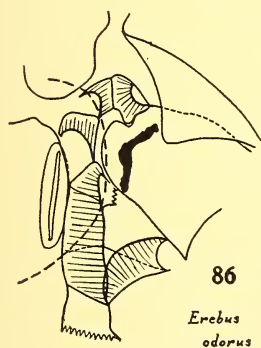
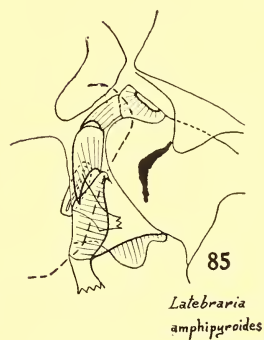
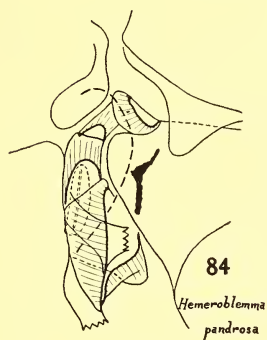
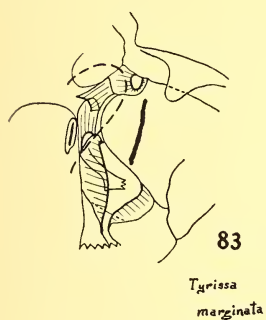
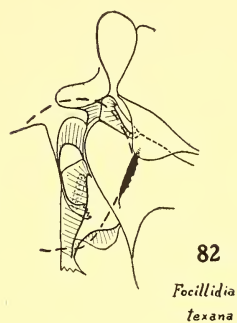
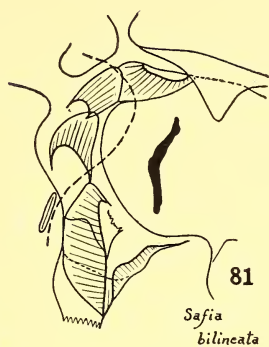
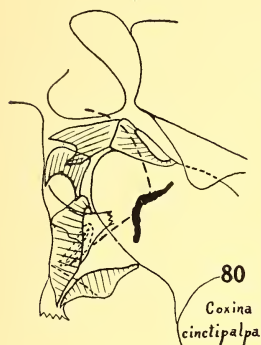
77
Pelamia
latipes

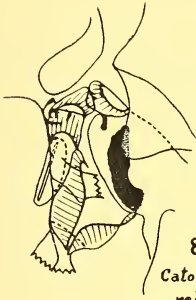


78
Selenis
sueroides



79
Ephesia
elonympha

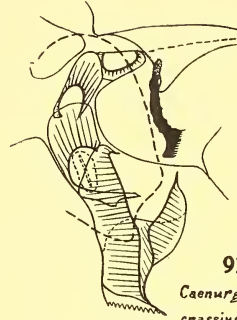




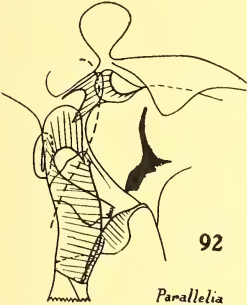
89
Catocala
relictæ



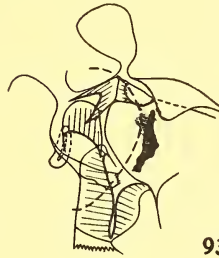
90
Ophideres
fullonica



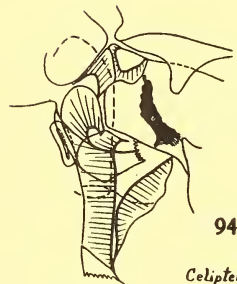
91
Caenurgìa
crassiuscula



92
Paralleliæ
bistriaris



93
Argyrostromia
anilis



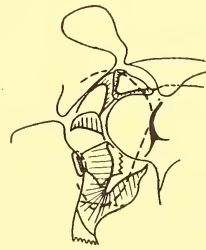
94
Celiptera
frustulum



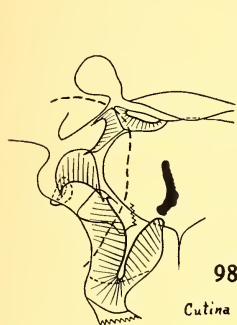
95
Euclidimera
caerulea



96
Phurys
lima

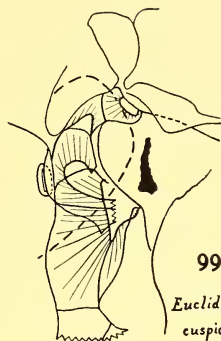


97
Doryodes
grandipennis



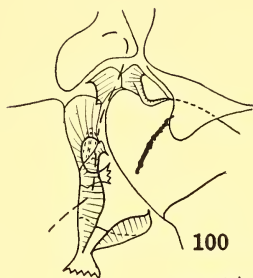
98

*Cutina
albopunctella*



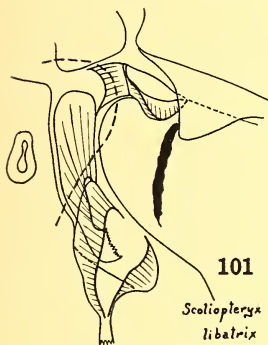
99

*Euclidia
cuspea*



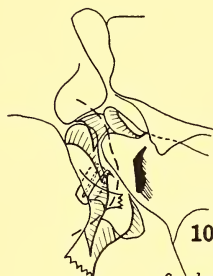
100

*Eulepidotis
illyrias*



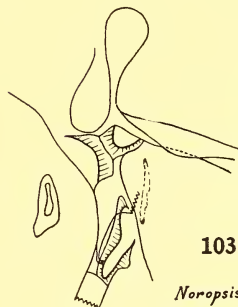
101

*Scoliopteryx
libatrix*



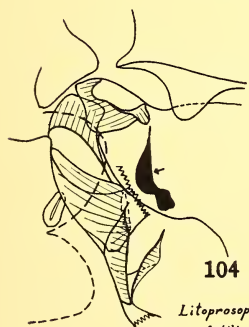
102

*Gonodonta
nutrix*



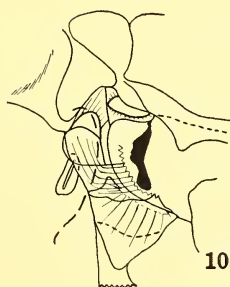
103

*Noropsis
hieroglyphica*



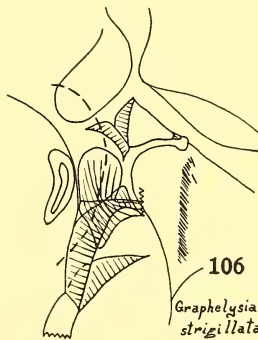
104

*Litoprosopus
futilis*



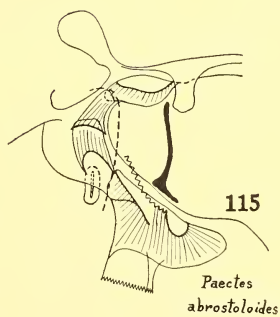
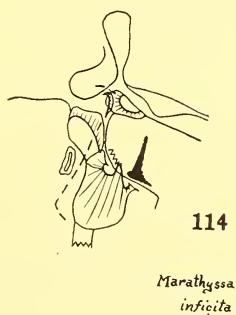
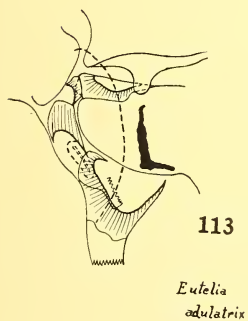
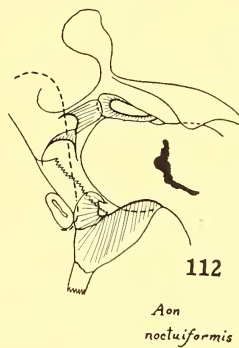
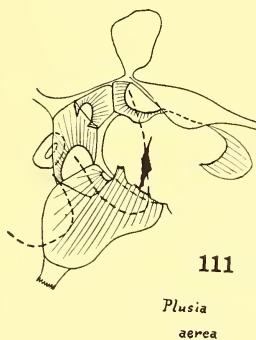
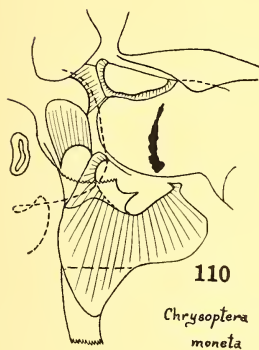
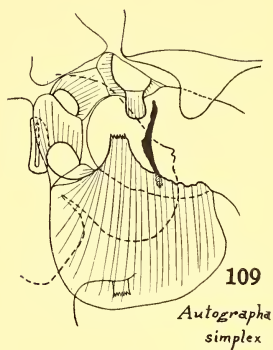
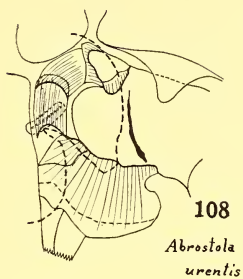
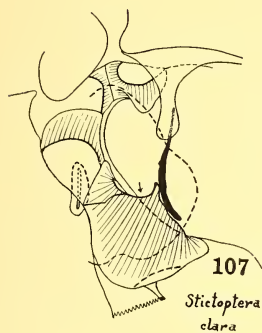
105

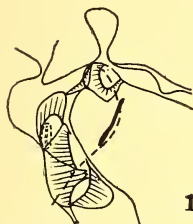
*Sosxetra
grata*



106

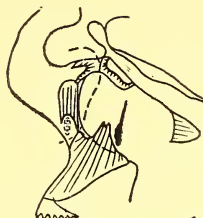
*Grapholysia
strigillata*





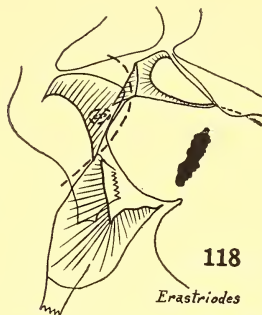
116

*Eublemma
obliquialis*



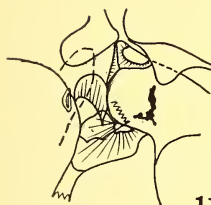
117

*Cobubatha
quadrifera*



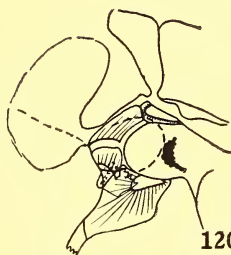
118

*Erastriodes
propera*



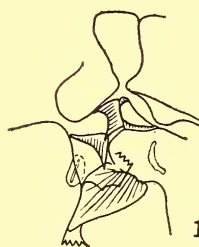
119

*Euxaonia
clarki*



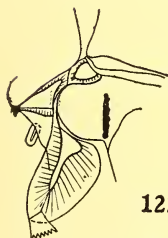
120

*Lithacodia
carneola*



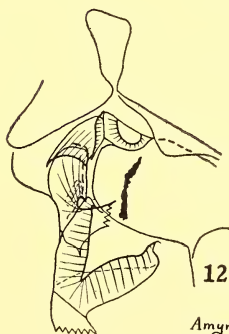
121

*Neotarache
deserticola*



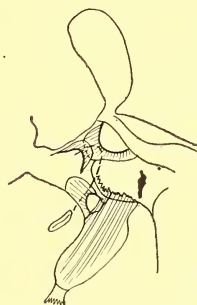
122

*Capis
curvata*



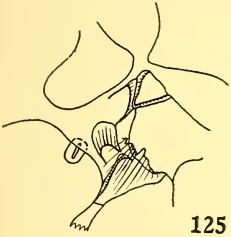
123

*Amyna
bullula*



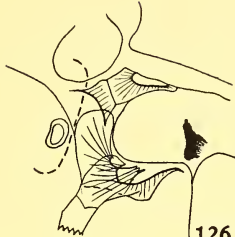
124

*Cydusia
nobilatella*



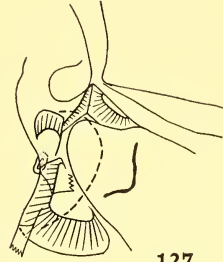
125

Grotelliforma
lactea



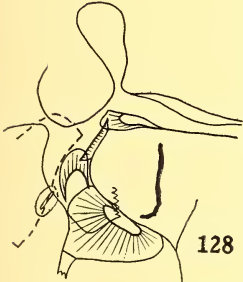
126

Homolagoa
grotelliformis



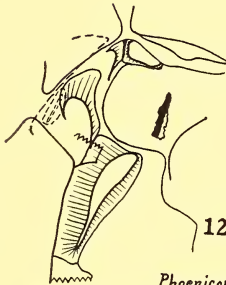
127

Oruza
albocostaliata



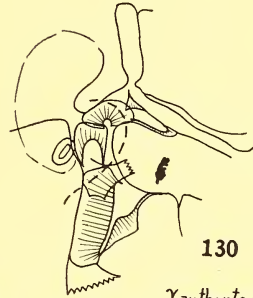
128

Phobolisia
anfracta



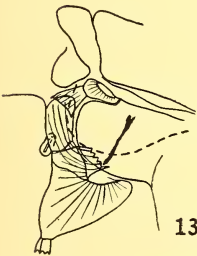
129

Phoenicophanta
bicolor



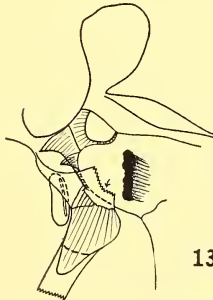
130

Xanthoptera
nigrofimbria



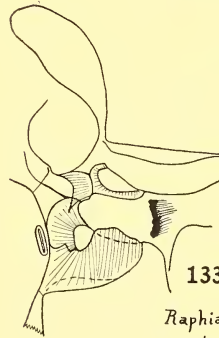
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Tarachidia
candefacta



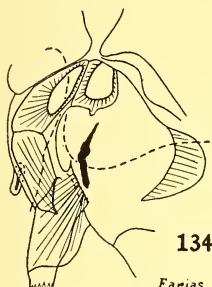
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Panthea
furcilla



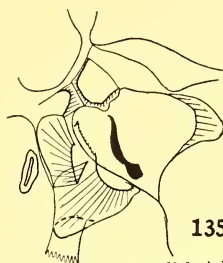
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Raphia
frater



134

*Earias
chlorana*



135

*Hylophila
bicolorana*



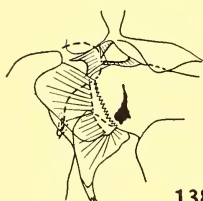
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*Sinna
extrema*



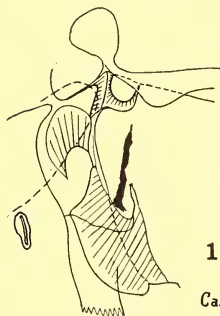
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*Bagisara
subusta*



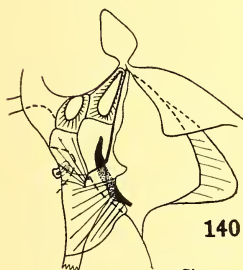
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*Baileya
ophthalmica*



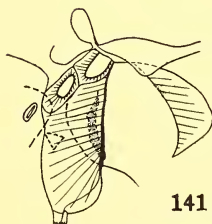
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*Casandria
abseuzalis*



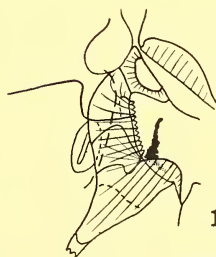
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*Characoma
nilotica*



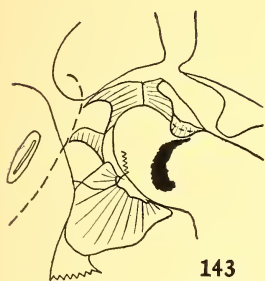
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*Sarrothrips
lintnerana*

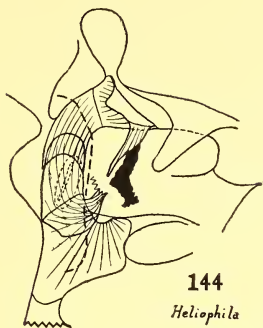


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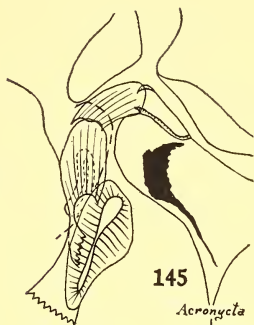
*Stictothrips
albescens*



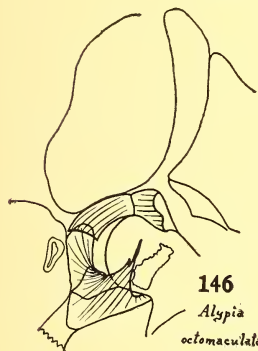
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Trachea
arcica



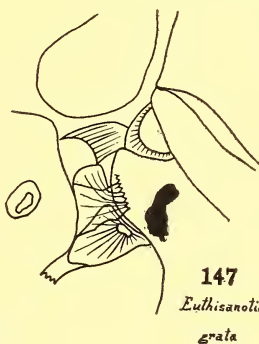
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Heliophila
unipuncta



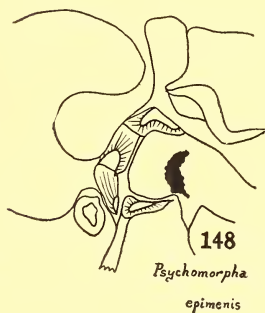
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Acronycta
americana



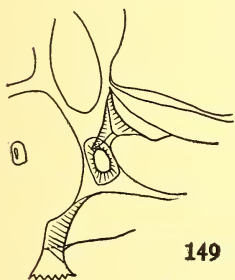
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Alypia
octomaculata



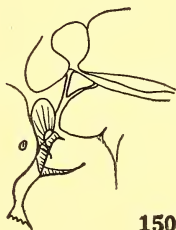
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Euthisanotia
grata



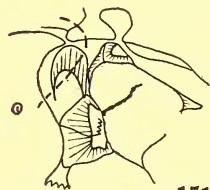
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Psychomorpha
epimenis



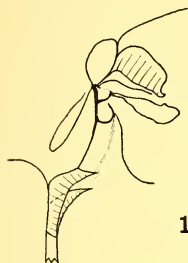
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Hypoprepia
miniata



150
Crambidia
pallida

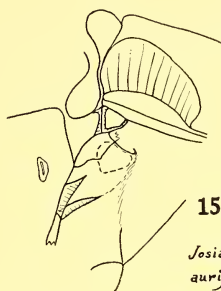


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Roeselia
minuscula



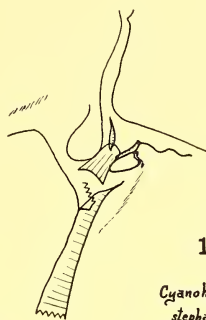
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Myonia
cingulina



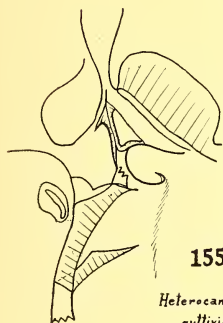
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Josia
auriflua



154

Cyanohypsa
stephanelli



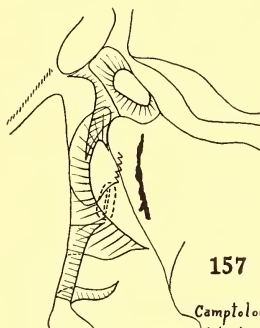
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Heterocampa
guttivitta



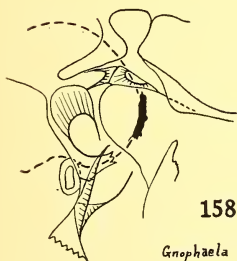
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Doa
ampla



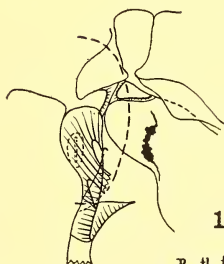
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Camptoloma
interiorata



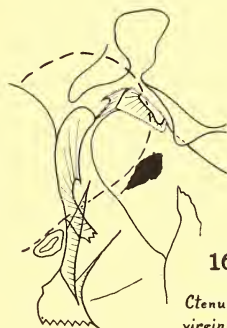
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Gnophæla
vermiculata



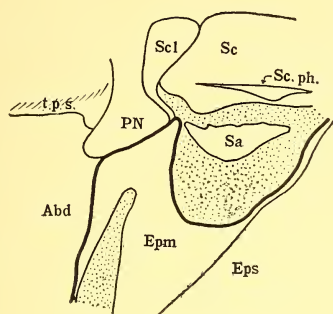
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Portheotria
dispar

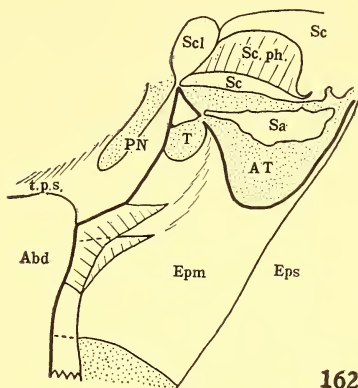


160

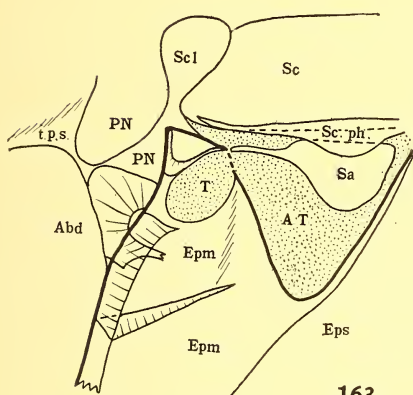
Ctenucha
virginica



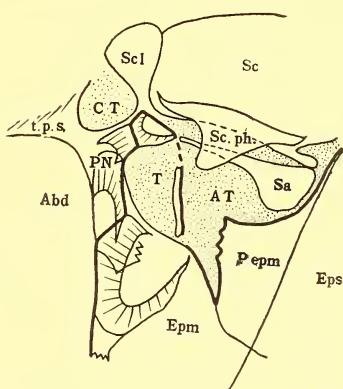
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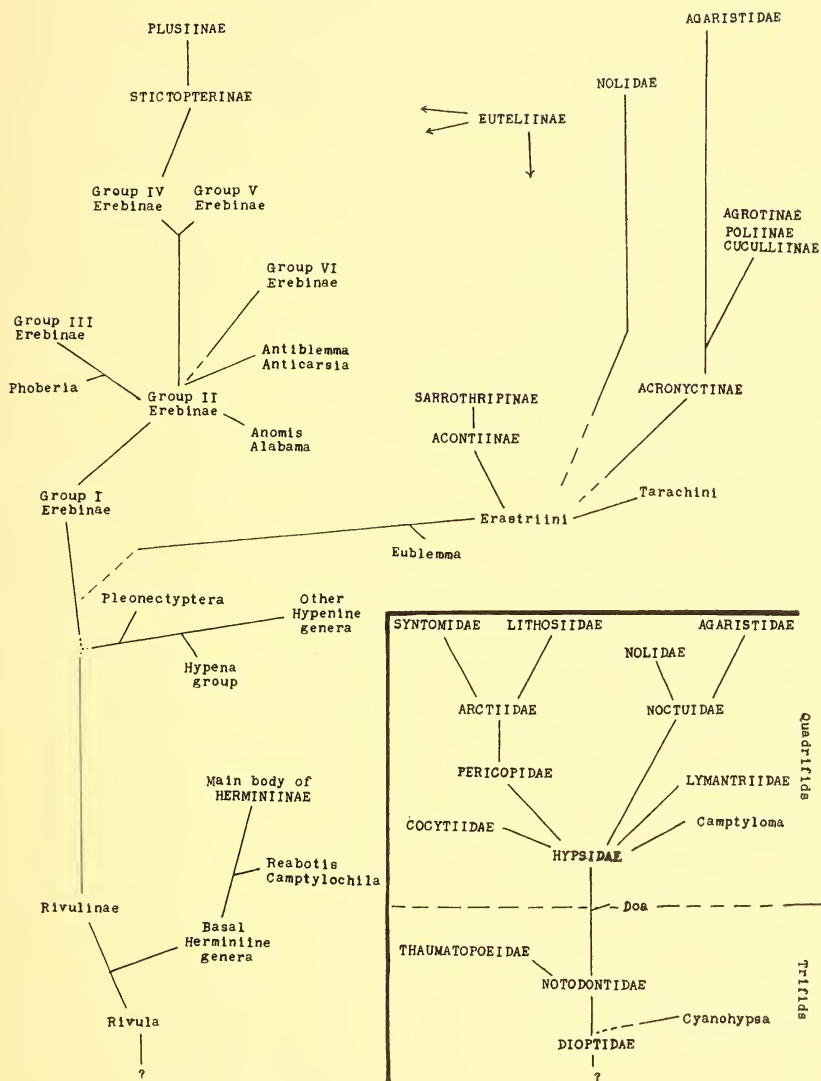
Fig. 161. Internal view of the posterior half of the metathorax of an non-tympanal form (based on *Yponomeuta*). The dorsal and posterior border of the epimeron is shown by the heavy line in all the figures on this plate.

Fig. 162. Internal view of *Myonia* (Dioptid) showing first tympanal modifications.

Fig. 163. Internal view of *Doa* showing transition to higher type.

Fig. 164. Internal view of higher Noctuid (*Calpe*) showing the final modifications and the limits of the contributing sclerites.

Abd., abdomen; *AT*, accessory tympanal membrane; *CT*, counter tympanal membrane; *Epm*, epimeron; *Eps*, episternum; *Pcpm*, preepimeron; *PN*, postnotum; *Sa*, subalar sclerite; *Sc*, metasecutum; *Scl*, metascutellum; *Sc. ph.*, scutal phragma; *T*, tympanal membrane; *t.p.s.*, tergo-pleural suture of first abdominal segment.



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SOME PACIFIC COAST OTIORHYNCHID WEEVIL LARVAE

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The necessity for recognizing larvae of immigrant and native Otiorhynchine weevils has led the writer into a study of the larvae of the subfamily. As a result, there have been brought to light, up to the present, a few interesting forms which may have phylogenetic significance. The following account has the main object in view of emphasizing morphological similarities and differences in the larvae of the species treated. Remarks on classification are made from the larval standpoint, only. Synopses have been resorted to in order to more clearly set forth the important points. The descriptions are so written that the treatment of corresponding characters occurs at approximately regular intervals in the text; and so that all variable structures may be compared throughout. These descriptions and synopses are for the purposes of this article and are subject to revision when the larvae of more species become known. It is not intended that the host records and distribution data be complete.

The author wishes to thank Dr. A. G. Böving and R. A. St. George who have placed certain extra-California larval forms in his hands for study. Dr. E. C. Van Dyke has kindly determined a number of adults reared from larvae. Other sources of material will be recognized as the species are mentioned.

EXPLANATION OF TERMS

The nomenclature of the various head and body areas is taken from the works of Böving, of Böving and Craighead, and of Cotton (see references). Where it has been found necessary to go beyond these, it is not with the intention to attempt the establishment of any new designations, but to clarify the studies in hand.

The number of setae stated for each body area will be those *on one side* of the middorsal and midventral lines; in other words, for one half of the larva. Thus the typical abdominal scutellum has in all ten setae, five on a side; only the five will be mentioned.

The setae on the frons and epicranium may be conveniently divided into several longitudinal groups; 1. the admedian frontal setae (mfs) with one long and two or three short, or minute setae; 2. the single sutural seta (ss); 3. a long admedian epicranial seta (adm); 4. three submedian setae with the first and third (sm1 and sm3) always long, the second (sm2) usually minute; 5. two long lateral setae (l one and l two); 6. two sublateral setae (sl) (next to cardo), of which one is most often minute; 7. the four posterior minute setae (pes). The groups of setae, under numbers 3, 4, 5 and 6 will be designated for convenience the "anterior epicranial setae." The sensory papillae have not been investigated. The genus *Pantomorus* possesses the frontal and sutural setae as above, but the epicranial setae are so greatly modified that their homologies are obscured.

Presumably, all these larvae have two spots or ocelli on each epicranial half for the reception of light stimuli. One of these spots is just lateral to the antenna; the other, on fully exposed heads, is near the first submedian epicranial seta (sm1). It does not appear, however, that all species have pigment in connection with these rudimentary ocelli. The presence or absence of this pigment is not always easy to determine as it may have retreated far into the head. The presence of pigment is stated as far as observed.

Mandibular structure varies according to the amount of use to which the mandibles have been subjected. The descriptions are as accurate as possible.

The shield is the sclerotinized dorsal area on the prothorax. This is variously modified, making its limits rather vague. It does not include the setae of the prothoracic epipleurum (the small setae cephalodorsad to the mesothoracic spiracle), although these may at times be connected by sclerotin to the shield proper.

"Longitudinal hyaline bands" are the light areas that lie near and parallel to the epicranial suture (eps) on the epicranium (and sometimes part of the frons) which are not as heavily sclerotized as the remainder of the head.

"Sclerites of mentum" (m) will designate the crossed, or "psi-shaped" sclerites that support the lower oral structures from beneath. They will be considered as complete when no part of the typical formation is absent.

"Prominent seta" is used for a hair easily visible under a low power binocular microscope. This is in opposition to minute seta. In general, there are three types of setae: *long setae*, *short setae*, and *minute setae*. Intergrades will be described as the need arises. Minute setae will generally be disregarded unless important. The long setae of the head are not as long as those of the body.

The scuto-scutella (sc-scl) of the mesothorax and the metathorax have four setae in a row or line, transverse to the body, and the scutella (scl) of at least the first seven abdominal segments have five setae in a row. For the purposes of this article, these will be temporarily designated I, II, III, IV consecutively, from the dorsum down, on the thorax, and I to V on the abdomen. As we proceed caudally, we find that on the last two or three abdominal segments some modifications or reductions have taken place, in different ways according to the genera and species. The identity of V on the eighth segment is in some cases in doubt as its place may have been taken by the long alar seta (al). On some species, the two are definitely distinct; on others, the long alar is apparently absent. Thus, in always designating this seta as V, when in doubt, convenience is considered the most important thing until the various identities can be definitely established.

It must be borne in mind that individual variation in the number of setae on any area often occurs and for that reason single specimens are sometimes more or less atypical.

GENERAL CHARACTERS

The larvae of the *Curculionidae* are Coleopterous larvae which usually have a curved (cyrtosomatic) body, no real molar structure on the mandibles, and a hypopharyngeal bracon. The gular region and true legs are absent. For further particulars, see Böving and Craighead (2).

The writer has examined all available material in an attempt to separate the larval *Otiiorhynchinae* as a group from the remainder of the *Curculionidae*. Some progress has been made but as the

examples studied are comparatively few (forty-nine Curculionid plus Scolytid genera and fifteen Otiiorhynchine genera) there is no way to be sure at the present as to just how well the characters investigated will stand. It must be pointed out, however, that the groups represented by these genera are not closely related and therefore somewhat representative of the whole family. The following account is offered for what is worth.

The Curculionid larval antenna consists of two segments: the first a membranous lobe bearing a number of sensory papillae; the second or apical segment sclerotized and of the various sizes and shapes as will be described. In all Otiiorhynchine genera examined, the apical segment has been found to be oval, blunt, and broader than long (see figs. 1A, 18A, 30). It is usually, though not always, over half as large as the basal segment and often subglobular. The typical apical antennal segment of the remainder of the family is much smaller than the basal segment, round and conical (see fig. 52 of *Hypera punctata* Fabr.). The most notable exception to this is found, as we would expect, in the genus *Sitona*. The *Sitona* larva has a fairly large oval apical antennal joint but possesses a median frontal carina, the latter absent from all Otiiorhynchids on hand. In the *Alophini*, we find that *Lepidophorus* has no carina and a fairly large apical antennal segment, which, however, is comparatively not as large as the typical oval segment described above, and is hemispherical. *Trichalophus*, also in the *Alophini*, has the same type of antenna as in *Lepidophorus*, but the apical segment is very small and there is a median frontal carina. Green Hyperine larvae have no carina but the apical antennal segment is small, round and conical. No apical antennal segment (with the exception of *Sitona*) has been found outside the *Otiiorhynchinae* which in any way resembles that of *Pantomorus* or *Brachyrhinus*. This segment may be very small in a few Otiiorhynchine species but should be always oval and blunt. The above information may be summarized as follows:

1. Apical antennal segment much smaller than basal, round at base, conical, or at least longer than wide; spiracles typically round, and with prominent annulate air-tubes which are often rather long; median frontal carina usually present
*Cossoninae*, *Curculioninae* in part
1. Apical antennal segment hemispherical or oval 2
2. Apical antennal segment hemispherical, of various sizes; spiracles round, lacking air-tubes; carina present and apical

- antennal segment small (*Trichalophus*) or carina absent and apical segment rather large (*Lepidophorus*)*Alophini*
2. Apical antennal segment oval, usually large 3
3. Median frontal carina present; lateral setae on anterior margin of epipharynx subulate; spiracles round, opening small, air-tubes long and annulate (figs. 50, 51)*Sitonini*
3. No carina; setae on anterior margin of epipharynx comparatively broad and blade-like, rather flattened; long or prominent air-tubes, when present on spiracles with small openings, lacking strong annulations*Otiorhynchinae*

Otiorhynchid larvae when mature are of different sizes according to the species but all those examined have the head varying from light yellow to a clear orange-brown and the body whitish, curved, and subcylindrical. Head (except certain forms with an elongate retracted head) but slightly longer from base of clypeus than wide; sides always curved; antennae as described; frontal sutures (fs) present or absent; epistome with a prominent lateral seta (sep); frons (f) without median frontal carina, with three or four setae and two sensory papillae; one prominent sutural seta usually nearer to apex of frons than to antenna; eight anterior epicranial setae on fully exposed heads; four minute posterior epicranial setae (pes); clypeus (cl) with two basal setae and a papilla; labrum (lbr) with three or four setae; epipharynx with five or seven blade-like setae (on each side) on front margin, three interior setae and a papilla, and a lateral longitudinal spinulate area; mandibles dark brown or blackish, with two apical teeth or without teeth, and two setae on outer surface; maxillary palpus (mxp) of two joints; maxillary mala with about twelve setae, part blade-like, part lanceolate; maxillae (mx) more or less entally and laterally spinulate; paragnaths (sides of hypopharynx) spinulate; labial palpus of two joints; sclerites of mentum (m) variable, but median longitudinal piece not known to be wanting. Body armed with an approximately regular pattern of setae which are usually stout and prominent; accessory setae known on at least one species; ventral and posterior setae usually stouter; skin varying from entirely spinulate to entirely smooth. Prothorax with variable shield, reduced epipleurum. Meso- (T2) and metathorax (T3) with three dorsal areas: prescutum (psc) with one seta (which is longer than corresponding setae on abdomen), scuto-scutellum (sc-scl) with four setae, and a non-setiferous poorly defined postscutellum (pscl); alar areas (a) bearing one or two setae; epipleura divided into

three areas each: preepipleurum (ea) always with a long seta and at least largely sclerotinized on the mesothorax; epipleurum proper (e) apparently with two variable setae and one minute seta, sclerotinized or not, mesoepipleurum fused with or partly separated from the mesopreepipleurum, metaepipleurum always separated from the metapreepipleurum; postepipleurum nonsetiferous. Thoracic hypopleura (hp) with two setae, one seta, one seta, respectively. Pedal lobes (cx of thorax) of all three segments with seven to nine setae, long to minute. Thoracic eusterna (eu) with one seta; poststernellum present, nonsetiferous. First seven abdominal segments similar, the third nearly always about the thickest part of the body; dorsum of each segment composed of: prescutum (psc), monosetiferous; scutum (sc), nonsetiferous; scutellum (sc1), with five setae, the lower four tending to be in two pairs; postscutellum (pscl) without setae. Alar area (a) of these segments situated just above spiracles and with one long (al) and one very short or minute seta: epipleurum (e) just below spiracle usually with two prominent setae, rarely with more; hypopleurum (hp) not more than one lobe, nearly always with two prominent setae next to parasternum but occasionally reduced; parasternum (cx of abdomen) with one seta; eusternum (eu) with two setae; poststernellum (post) present on each of these seven segments but bearing no setae. Eighth segment resembling the first seven except the dorsum: scutellar setae often reduced in number and often either the long alar (al) or the lowest scutellar seta (V) absent; no definite postscutellum. Ninth segment still further reduced: dorsum composed of one lobe; epipleurum and hypopleurum fused into a large double rather vertical lobe with two (rarely three) setae dorsad, one usually minute; no parasternal seta; two eusternal setae. Tenth segment always unsclerotinized, very reduced, terminal or caudo-ventral in position, bearing two or three setae on a side. In some cases the abdomen may be largely sclerotinized on the eighth and ninth segments, in addition to or as an enlargement of the usual tubercles. The spiracles are all lateral: one on thorax on a mesothoracic lobe into the prothorax; one on each of first eight segments; form variable according to the genus.

SYNOPSIS OF GENERA

1. Head lightly sclerotinized except anterior margin, light colored, frontal sutures absent; prothoracic shield with nine or ten setae, those on the anterior margin fairly evenly dis-

- tributed; pedal lobes with eight or nine setae (including minute setae) 2
1. Head more or less heavily sclerotinized, usually clear orange-brown, frontal sutures present; prothoracic shield with eight or nine setae, the highest seta on the front margin distinctly isolated; pedal lobes with seven or eight setae.....5
 2. Head retracted into thorax, considerably longer from base of clypeus than wide; two prominent setae on epicranium; skin with few spinules; large alar seta apparently absent from eighth segment; no largely sclerotinized posterior areas; tenth segment terminal; spiracles comparatively large, vertically oval, opening large and inner opening of atrium protected with fringed processes, air-tubes present but rudimentary *Pantomorus*
 2. Head fully exposed, hardly longer from base of clypeus than wide; six to eight prominent epicranial setae; large alar seta always present on eighth segment; eighth and ninth segments largely sclerotinized; tenth segment caudo-ventral; spiracles various but lacking air-tubes 3
 3. Frons with but one prominent frontal seta; second submedian epicranial seta minute; basal segment of maxillary palpi as long as apical; skin without spinules; five scutellar setae on eighth segment; neither epipleurum nor hypopleurum modified; six setae (including both sides) closely grouped on posterior part of dorsal ninth lobe; spiracles comparatively large, vertically oval, opening large and with fringed protecting processes *Rhyncogonus*
 3. Frons with more than one prominent frontal seta; second submedian epicranial seta short, prominent; basal segment of maxillary palpi reduced, shorter than apical; skin heavily spinulate; less than five scutellar setae on eighth segment; spiracles not large, round, opening small and round 4
 4. Sclerites of mentum complete; thoracic alar areas with two prominent setae; abdominal epipleura each with more than two (six to thirteen) prominent setae; hypopleura with two prominent setae each; three scutellar setae on eighth segment; one seta on side of dorsum of ninth; abdomen thickest at center of body *Trigonoscuta*
 4. Lateral arms of sclerites of mentum incomplete at base; thoracic alar areas with one prominent seta; abdominal epipleura with two setae each; hypopleura of first seven segments with but one prominent seta, the other seta very small; four scutellar setae on eighth segment; three setae

on side of dorsal ninth lobe at points on an inwardly oblique line; abdomen thickest at seventh segment

..... *Mesagroicus*¹

5. Head with seven prominent epicranial setae (both sublaterals prominent); a longitudinal hyaline area parallel to epicranial suture including part of frons; skin completely spinulate (except sclerotizations); nine setae on prothoracic shield; one prominent hypopleural seta on abdomen; four setae on scutellum of eighth segment; spiracles circular, opening round, air-tubes absent

..... *Dyslobus*

5. Head with six prominent epicranial setae; longitudinal hyaline areas when present not including part of frons; skin with comparatively few inconspicuous spinules; eight setae on prothoracic shield; two prominent hypopleural setae on abdomen; five setae on scutellum of eighth segment (in some cases II may be minute or anterior); spiracles circular, nearly always before

..... 6

6. Meso- and metastauto-scutellum with seta IV always separated from upper three which are usually on same tubercle; no posterior segments largely sclerotized (except on setiferous tubercles); sternal setae of ninth segment about the same as those on preceding segments

..... *Brachyrhinus*

6. Meso- and metastauto-scutellum with seta I always separated from lower three; part of seventh and approximately all of eighth and ninth segments rather heavily sclerotized;

¹ Larvae, that it is reasonable to believe represent *Stamoderes uniformis* Casey, have been collected since this manuscript was submitted. They fit in remarkably well with *Trigonoscuta* and *Mesagroicus*, more nearly resembling the latter, but amply distinct from both in a number of details. The most interesting feature, from the standpoint of this synopsis, is the sclerotin on the head capsule. This sclerotization not only occupies the anterior margin (as in *Trigonoscuta* and *Mesagroicus*) but extends a short distance back onto the frons and epicranium. The hyaline space in this sclerotization on the front margin, laterad to the antennae, could be interpreted as the base of the frontal suture. If so, it would then appear that the reason for the absence of frontal sutures is due to the lack of general head sclerotization. (The head of *Polydrusus* is little darker than that of *Mesagroicus* or *Trigonoscuta*, but the frontal sutures are distinct.) The frontal sclerotization on *Stamoderes* tapers to a slight line in the middle of the frons. This line probably represents the median frontal carina, a character relied on herein to separate *Sitona*.

sternal setae of ninth segment moderately short, very stout,
sub-parallel 7

7. Epicranium with a rather short longitudinal hyaline band from frontal suture to admedian epicranial seta; III on posterior margin of eighth segment usually closer to I than to IV; one long and two minute setae on frons; all spiracles bifore *Peritelinus*
7. Frontal suture (fs) widened centrally but no hyaline band; seta III on posterior margin of eighth segment half way between I and IV or closer to IV; one long and three minute setae on frons; spiracles varying from all bifore to none bifore *Geoderces*

Genus PANTOMORUS Schon.

Head elongate, distinctly longer from base of clypeus than wide, light yellow, lightly sclerotinized except anterior margin which is heavy; retracted over half its length into thorax; frontal sutures and hyaline areas absent; frons with one prominent and three minute setae; epicranial setae reduced in size and pushed forward, two prominent setae remaining on epicranium; ocellar pigment present; antennae with comparatively large oval apical joint; epipharynx with five setae on front margin, the three internal setae of one side rather widely separated from those opposite; mandibles with two apical teeth, when not worn; maxillae spinulate on ental and outer sides, the ental spinules near the palpi unusually long; maxillary palpi with basal segment not reduced, as long as apical; sclerites of mentum complete, no extra thickenings; subfacial area not spinulate. Body white, robust, not particularly tapering at either end, thickest approximately at center; cyrtosomatic; no extra prominent lobes nor largely sclerotinized caudal areas (except tubercles); setae brownish, long, slender and tapering, conspicuous; setiferous tubercles fairly large and prominent, often confluent; a few ventral skin spinules. Thorax: shield with nine setae, four evenly spaced along anterior margin; mesoscuto-scutellum with I medium length, separated from the remainder which are equidistant, II short, III long, IV almost medium length; metascuto-scutellum the same, but IV further from III; alar area of mesothorax with two setae, one short, one very short, the metathorax with two short alars; mesoepipleurum with one long and two minute setae, this area sclerotinized and fused with mesopreepipleurum; metaepipleurum with one long, one short and one minute seta, distinct from metapreepipleurum; pedal lobes with nine setae, one of which is minute, the rest prominent. Ab-

domen: scutellum of first seven segments with I rather short anteriorly, becoming longer caudad, II and IV short, the latter becoming longer caudad, III and V long; epipleurum and hypopleurum of all segments with two prominent setae; eusternal setae all the same length. Eighth segment as those previous except the dorsum: I moderately long, II lost, III long, IV medium length, V long and on same sclerotization as IV, long alar apparently absent. Dorsum of ninth segment with three setae, a line drawn between each forming a very obtuse angle inward; lateral lobe with a long and minute seta above; eusternal setae as those previous, unmodified. Tenth segment terminal, membranous, all setae very short. Spiracles: rather large, oval, more nearly vertical, mesothoracic largest, not twice as long as wide, opening almost as large as atrium (atr), air-tubes (at) rudimentary, not projecting; spiracular opening protected by long fringed processes.

Pantomorus godmani (Cr.)

(Fullers Rose Beetle)

Figs. 8, 8A, 8B, 8C, 9, 10, 10A, 11

This is the only species of the genus available in the larval stage. The larvae are rather robust, not especially tapering, and the blackish mandibles contrast with the light retracted head and white body. Length, 11½ mm.

Distribution in California: general, but the species is more apt to appear in large numbers in the South.

Hosts: a general feeder on shrubs and young trees.

Larvae are best taken in the early spring, though they may occur during the summer. Adults have been reared and correlated with larval skins.

While this insect is here termed *Pantomorus godmani* Cr., it has not always possessed that designation in the past (see Leng Catalog, 1920). The latest name used by the U. S. Bureau of Entomology is *Asynonychus godmani* Cr.

The retracted and elongate head of *Pantomorus* is similar to a number of genera in the *Curculioninae* and *Scolytidae*. All these latter have frontal sutures, however. Larvae of *Naupactus* (South America) can hardly be separated from *Pantomorus*. *Epicaerus*, as exemplified by *cognatus* Sharp (Mexico) is close to *Pantomorus* according to larval form, and definitely in the same series. The head of *Epicaerus* is elongate and retracted. The body is robust but the setae are shorter and of slightly different arrangement.

The spiracles of *Epicaerus* are not quite as large as those on *Pantomorus* but of the same shape and orientation; small, strongly annulate air-tubes project a short distance from the upper end; the inner opening is narrowed but there are short spinose processes.

Genus RHYNACOGONUS Sharp

(Figs. 47, 48, 49)

A description of this genus does not properly belong in this paper but as *Rhynacogonus* possesses, in common with *Trigonoscuta* and *Mesagroicus*, several notable characters, a short résumé of its morphology will be given. The head lacks frontal sutures but is fully exposed and not much wider than long. There is one prominent admedian frontal seta, and seven prominent epicranial setae. The basal segment of the maxillary palpus is unreduced. The skin is entirely lacking in spinules. Ten setae are on the shield; two thoracic alar setae; two prominent setae on the epipleurum; eight setae on pedal lobes. The abdomen has no accessory setae except possibly one on the lateral lobes of the ninth segment. No reductions in setae have taken place. The eighth and ninth segments are largely sclerotinized, especially the large lateral lobes of the ninth. The ninth segment is conspicuously elongate. The epipleura, especially on the seventh and eighth segments, possess a peculiar disc-like structure. The tenth segment has been pushed down to a caudoventral position. The spiracles are rather large and vertically oval with a large opening. This opening is protected as in *Pantomorus* by numerous spinose processes. The inner opening of some of the abdominal spiracles has been narrowed, reducing the length of the spinose processes.

The species studied is *extraneus* Perkins, kindly sent to the writer by Mr. O. H. Swezey. It occurs in the Hawaiian Islands.

The maxillary palpi, form of spiracles, and lack of skin spinules seem to be correlated with *Pantomorus* and *Epicaerus*. On the other hand, the fully exposed head, retention of the long alar seta on the eighth segment, the caudal sclerotizations, the depression of the tenth segment, and loss of spiracular air-tubes, incline toward *Mesagroicus* and *Trigonoscuta*. The peculiar disc-like structure on the abdominal epipleura of *Rhynacogonus* and *Trigonoscuta* should be noted.

Genus TRIGONOSCUA Mots.

Head: yellow, not heavily sclerotinized except on anterior margin, very little longer from base of clypeus than wide, fully

exposed; frontal sutures and hyaline areas absent; frons with one long admedian seta, two very short setae, one minute seta; eight anterior epicranial setae, six of which are long and two short but not minute, notably second subdorsal seta (sd2); ocelli pigmented; antennae with large oval apical segment, somewhat produced laterally; epipharynx with five setae on anterior margin and three inner setae on each side, these last notably close to opposite three; mandibles with two apical teeth; maxillae with some spinules on ental and outer surface, none extra long; basal segment of maxillary palpus reduced to a ring, much shorter than apical; sclerites of mentum complete, rather slender, longitudinal piece rather short and base of lateral arms light; subfacial area spinulate. Body: white, robust and not particularly tapering, somewhat curved, thickest near middle; lateral lobes rather produced, especially those caudad; last two or three segments (excepting tenth) largely sclerotinized; setae of moderate length only, hardly contrasting with body color, mostly tapering but most of the lateral and posterior setae linear-lanceolate; ventral setae distinctly heavier; tubercles usually small, each seta tending to be on a separate sclerotinization; skin, except sclerotinized areas, thickly set with rather inconspicuous, though comparatively long, spinules. Thorax: shield with ten setae, four along anterior margin subequally placed; scuto-scutellar areas with moderately long setae, I and IV further from II and III than these last are from each other; alar areas with two moderately long setae, those on the metathorax more widely separated; mesopreepileurum largely sclerotinized but metapreepileurum with a small tubercle; meso- and metaepileurum almost unsclerotinized, with two medium length setae and a minute seta; both epipleural lobes separate from the preepileura; pedal lobes with eight prominent setae and one minute seta. Scutellum of first seven abdominal segments with I about medium length, II short, III rather long, IV short, V as III, all becoming longer caudad and V receding from IV; epipleural areas large, with six to eight (or more) linear-lanceolate moderately long setae and a faint disc-like structure which is more easily seen caudad; hypopleura with two setae of moderate length; eusternal setae equal in length. Scutellum of eighth segment with three long setae; long alar present; epileurum as described for preceding but disc-like structure very large and prominent; the two eusternal setae of each side linear-lanceolate and nearer each other than those opposite. Dorsum of ninth segment with a lateral prominent seta; lateral lobes with a caudodorsad prominent seta, a dorsad minute seta, and a short ventrad projection; eusternal setae about as those on

eighth. Tenth segment caudoventral, membranous, with one prominent and two very small setae. Spiracles: small, circular, air-tubes absent, opening small, all about the same size.

Trigonoscuta pilosa Mots.

(Figs. 38, 38A, 38B, 39, 39A, 40, 41, 42)

This seems to be the only species of the genus. The larvae are white, practically unicolorous throughout, robust, head rather projecting ventrally, body blunt caudally, hardly tapering. It burrows in the sand of the ocean dunes. Specimens 12 or 12½ mm. long are on hand. Adults burrow as well as the larvae but not as far down.

Distribution in California: along the ocean.

Hosts: the writer has only collected these from Strawberry roots, though Lupine and other plants may be fed on when available.

Larvae can probably be collected throughout the year. No adults were reared, but as a number were closely associated with larvae in a few feet of sand, it seems quite reasonable to conclude that the identity is established. No other Otiiorhynchid was found in this place.

Genus MESAGROICUS Schon.

Head yellow, not heavily sclerotized except on anterior margin, very little longer from base of clypeus than wide, fully exposed; frontal sutures and hyaline areas absent; frons with one long and two short admedian setae (one seta apparently absent); eight anterior epicranial setae, all prominent (including second submedian and both sublateral setae, which are short); pigmented ocelli present; antennae with subglobular apical segment; epipharynx with five setae on anterior margin and three inner setae (on each side), these last three close to the opposite three; mandibles toothless; maxillae with short spinules on ental and outer surfaces; basal segment of maxillary palpus reduced, little more than a ring of sclerotin, shorter than apical segment; sclerites of mentum incomplete, the side pieces not distinctly joined to the central longitudinal piece; subfacial area apparently spinulate in part. Body white, not very robust but not tapering from middle, not particularly curved, abdomen thickest at seventh segment; no lateral lobes more prominent than usual; large caudal sclerotizations (on eighth and ninth segments); setae short or of moderate length only, almost the same color as the body, regularly tapering; tubercles usually very small; skin thickly set with comparatively long spinules which obscure the very short and minute setae. Thorax: shield with nine setae, the four

along anterior margin subequally placed; mesoscuto-scutellum and metascuto-scutellum with I and II short, III moderately long and close to II, IV not as long as III, I and IV isolated; one seta of moderate length on alar areas; mesopreepipleurum largely covered with sclerotin, metapreepipleurum with a small tubercle; epipleura of last two segments separate from preepipleura and with a moderately long, a short and a minute seta; thoracic hypopleura with moderately large tubercles; pedal lobes with six prominent setae and apparently but two minute setae. First seven abdominal segments: prescutal seta short, slightly longer on seventh segment; scuto-scutellum with I short, somewhat longer caudad, II and IV short, III and V long; short alar seta almost entirely obscured by spinules; epipleural areas rather large, with a long and short seta, no unusual structures; hypopleura with a long and a minute seta; outer eusternal seta longer than inner; ventral tubercles of seventh segment somewhat larger than those previous. Eighth segment: large dorsal and lateral sclerotizations; no prescutal seta; four scutellar setae, I apparently absent, II and IV moderately long, III and V long; long alar present but reduced; epipleurum with two long setae on large sclerotized tubercle; hypopleurum with a long and a very short seta on large sclerotized tubercles; ventral sclerotized tubercles somewhat larger, those on eusternum joined. Ninth segment somewhat elongate and narrowed posteriorly, heavily sclerotized; dorsal lobe elongate and acutely tapering, three long setae along each side; lateral lobes produced into a flat "foot" behind, two rather long stout lateral setae nearer dorsal edge; eusternal setae rather long and stout. Tenth segment caudo-ventral, membranous, possessing one long seta and one rather short seta. Spiracles small, round, no air-tubes, opening rather small, mesothoracic somewhat larger.

Mesagroicus sp.

(near *hispidus* Buch. and *strigisquamosus* Buch.)

(Figs. 43, 44, 44A, 45, 46)

Approximate length of longest larva examined is $5\frac{1}{2}$ or 6 mm. This is a small white species, the sclerotin light colored and not contrasting with body color.

Distribution in California—Sierra foothills.

Hosts: the author collected larvae from near *Ceanothus cuneatus*, but presumably grass roots were fed on at least in part.

Larvae are present as late as the middle of May. One adult was reared and determined as a species of this genus through the

kindness of Mr. L. L. Buchanan. A larval skin is associated with this adult.

The three genera *Rhyncogonus*, *Trigonoscuta* and *Mesagroicus* constitute a remarkable series of forms, especially after one is accustomed to examining *Brachyrhinus* and *Pantomorus*. There are several good larval reasons for believing that they are more closely related to each other than to any others mentioned in this paper, as indicated in the generic synopsis. Larvae of *Mesagroicus* and *Trigonoscuta*, while not exactly close taxonomically, possess several notable similarities: 1. skin spinules; 2. general color of head, body and setae; 3. form of spiracles; 4. reduction in length of basal segment of maxillary palpus; 5. increased size and length of the normally small frontal and epicranial head setae. These characters also differentiate *Mesagroicus* and *Trigonoscuta* from *Rhyncogonus*. The form of the caudal sclerotizations and the position of the tenth segment are among the most noteworthy characteristics of these three genera. The writer has not seen fully exposed heads lacking frontal sutures, elsewhere.

The remainder of the genera are grouped together because they possess frontal sutures on the larval head. As well as those described at length, *Polydrusus*, *Pachnaeus*, *Diaprepes*, *Exopthalmus*, and *Trypopermnon* belong here.

While it is difficult to make definite statements of other characters than the frontal sutures which separate this group from the former, these larvae seem to be distinct as a whole. The position of the setae on the anterior margin of the shield is consistent, and usually there are fewer setae on the shield and pedal lobes (see generic synopsis). These larvae taper more, from the middle to the ends. The spiracles are usually round and with a small opening. Air-tubes present on spiracles of this form usually lack annulations, or are only weakly annulate. The large oval spiracle of *Diaprepes* would not appear to be correlated with that of the *Pantomorus-Epicaerus* group. It is only in this series possessing frontal sutures, that longitudinal hyaline bands are found.

It must be admitted that when more forms are known this grouping based on frontal sutures may give way. It is justified in the light of present information, however.

Genus DYSLOBUS Lec.

Head brownish, rather heavily sclerotized for the greater part, not much longer from base of clypeus than wide, fully exposed; frontal sutures present; a longitudinal moderately

wide hyaline area on each side of epicranial suture, sometimes not separated from this suture, extending from the prominent admedian frontal seta to near the posterior margin; frons with one prominent admedian seta (mfs) and three minute setae; the usual eight anterior epicranial setae present, with the second submedian (sm2) minute, but both sublaterals prominent; pigmented ocelli present; antennae with large, oval, blunt, apical joint; seven setae on front margin of epipharynx, and three interior blade-like setae, these latter rather close to the opposite group; mandibles with two teeth when not worn; maxillae with few spinules on ental and outer sides (variable); basal and apical segments of maxillary palpi unreduced, subequal in length; sclerites of mentum complete and moderately thick; subfacial area devoid of spinules. Body white; cyrtosomatic, thickest in center; no extra prominent areas nor largely sclerotinized caudal areas; setae rather thin, regularly tapering, brownish, none very prominent; setiferous tubercles typically quite small, not usually confluent, except some ventral and posterior; skin thickly set with rather prominent spinules, except on tubercles and intersegmental areas. Shield of thorax with nine setae, four setae on front margin with the highest distinctly isolated. Meso- and metascuto-scutellum with I, II and IV rather short, III long, II and III tending to be closer to each other than to others especially on latter segment; alar areas of last two thoracic segments with two short setae, those on the metathorax further apart; mesopreepileurum largely sclerotinized; metapreepileurum with a small tubercle; meso- and metaepileurum each with two short setae and small sclerotinization, neither united with preepileurum; pedal lobes with eight setae, two of which are minute (in part obscured by spinules), the remainder long. Scutellum of first seven abdominal segments with I, II and IV short, III and V long; epileurum with a long seta and a medium length seta; hypopleurum with a long seta and a minute seta; eusternal setae of equal length. Scutellum of eighth with II missing or I ?), all slightly longer than usual, IV closer to V than to III, large alar apparently absent; pleural areas as mentioned previously. Ninth segment with three dorsal setae at points of a triangle, apex forward; lateral lobe with a long seta and minute seta dorsad; eusternal setae unmodified. Tenth segment terminal, membranous, with very small and minute setae. Spiracles round; air-tubes absent; opening round, not more than one half the atrium; mesothoracic about twice as large as abdominal spiracles.

The genus *Dyslobus* is quite different from any of the other genera examined. The writer received the Oregon species by ex-

change from Mr. J. Wilcox. Two unidentified larvae of this genus are on hand. The following specific distinctions are not very good but may hold in a majority of cases.

SYNOPSIS OF SPECIES

Epicerianial suture edged with sclerotin; setae longer than in the following species, the spinules not as long; spiracular opening smaller; setae on dorsal ninth usually on more or less confluent sclerotinized tubercles*decoratus* Lec.

Epicerianial suture edged with sclerotin; setae not as long as *decoratus*; spinules more conspicuous, quite heavy; spiracular opening larger; setae on dorsal ninth on separate sclerotinized tubercles*ursinus* Horn.

Epicerianial suture not edged with sclerotin, at least anteriorly; setae not as long as *decoratus*; spinules more conspicuous, heavy; spiracular opening larger; setae on dorsal ninth on separate sclerotinized tubercles*granulatus* Csy.

Dyslobus decoratus (Lec.)

(Figures 1, 1A, 2, 2A, 3, 3A, 5, 6, 6A)

Larvae up to 10 mm. in length have been examined. The body is rather robust, curved, somewhat tapering. Head brownish with two median longitudinal whitish unsclerotinized areas, rather wide and prominent (figure 1); epicerianial suture bordered with sclerotin; seven prominent epicerianial setae; few spinules on ental side of maxillae. Body generally covered with spinules except on sclerotinized areas. Some of the setigerous tubercles tending to be rather large and confluent, the majority small. Spiracular opening comparatively small. Setigerous tubercles on dorsum of ninth segment tending to be large and confluent, usually uniting all of the posterior tubercles, and sometimes taking in the tubercle of the anterior seta, the spinules are thus restricted and do not occur between the setae, at least not between the posterior lateral and the nearest posterior median seta (see figure 5). (It is not improbable that spinules may be between all of these setae on some individuals, which specimens would then be indistinguishable from *ursinus* by that character.)

Distribution: Oregon; Del Norte County, California.

Host: destructive to Strawberries in Oregon.

Larvae may be collected in August. The rearings are by Mr. J. Wilcox.

Dyslobus ursinus (Horn.)

(Figure 4)

Individuals as long as 9 mm. have been examined. These larvae are very close to *decoratus*. Such differences as are enumerated are very slight and comparative. In *ursinus*, the white bands on the head tend to be narrower; the sclerotin edging of the epicranial suture is present. The maxillae have more internal spinules. The body spinules are generally denser; the setae are shorter, and the sclerotization much smaller around their bases; the setae on the dorsal ninth are all separated by spinules (see figure 4). All of the spiracles tend to have larger openings.

Distribution: Oregon: Northern California ?

Host: destructive to Strawberries.

Larvae occur in August. Mr. J. Wilcox has reared the species.

Dyslobus granulatus Casey

(Figure 7, 7A)

Larvae $7\frac{1}{2}$ mm. long were induced to pupate. This species is more like *ursinus* than *decoratus*, both in vestiture of adult and larva, but smaller. The most notable difference which sets this species off from the two previously mentioned is the absence of the sclerotin edging along the epicranial suture. The body setae are generally shorter and those on the dorsal ninth placed closer together. All tubercles separated on the dorsal ninth of the specimens examined.

Distribution: Sierra Nevadas (Placer County).

Host: Strawberries.

Five larvae were collected in August by the writer and one adult reared, with a larval skin as proof of its correlation.

Genus BRACHYRHINUS Bedel.

Head orange-brown, heavily sclerotized, little longer from base of clypeus than wide, fully exposed; frontal sutures present; no hyaline areas; one prominent and three minute frontal setae; six of the eight anterior epicranial setae prominent, with the second submedian (sm2) and one sublateral minute; pigmented ocelli (oc) present or absent; antennae with large oval apical joint, flattened apically or subglobular; epipharynx with five anterior marginal setae, the interior setae rather widely separated from each other and those opposite; mandibles, when not worn, with two apical teeth; ental side of maxillae somewhat spinulate; maxillary palpus unreduced,

segments about of equal length; sclerites of mentum complete, thickness variable; subfacial area with no spinules. Body white, curved, subcylindrical, thickest centrally and somewhat tapering to both ends, especially caudally, no extra prominent lobes nor large sclerotinized caudal areas; setae slender, tapering regularly, contrasting with body color; setiferous tubercles generally large, tending to be confluent; spinules present but inconspicuous, often rather blunt, and not covering entire body surface. Thorax: shield with eight setae, the anterior margin with one isolated near middorsum and three close together near lateral edge; mesoscuto-scutellum with I long or short, II and IV medium length, III long; metascuto-scutellum variable; scuto-scutellar setae on both segments with first three equidistant and one same compound tubercle (or sometimes I somewhat separated), IV distinctly isolated and on single tubercle; alar areas of meso- and metathorax with one long or one medium length seta; meso- and metaepipleurum with either a long seta and two minute setae, or with three minute setae, the former united with the preepipleurum, forming a large sclerotization, the latter also sclerotinized but distinct; pedal lobes with seven or eight setae. Scutellum on each of first seven abdominal segments with I long or short, II and IV short, III and V long, the last four in pairs, II in part tending to be caudally reduced in size and anterior to the line; epipleural and hypopleural areas with one long and one medium or short seta each; eusternal setae equal in length. Eighth segment about the same as those preceding, II of scutellum on part of species minute and pushed anterior, the large alar seta apparently absent. Dorsum of ninth with three setae variably placed, lateral lobe with a long seta and a minute seta dorsad, eusternal setae normal. Tenth segment terminal, membranous, and bearing three extremely small setae. Spiracles round or somewhat oval, bifore; mesothoracic spiracles largest; air-tubes more or less projecting, without annulations.

Five members of this large palearctic genus have found their way to California. The present distribution of these within the state is different in each case and some seem to be more destructive than others. For that reason, it is important to know what species any larva that is found represents. The key to four of these, by Lockwood and Keifer (5), which was based on spiracles alone, has since been found to be inadequate. Judging from the great diversity in size and form exhibited by the adults, the final definition of the larvae will be much broader than is allowed by the five immature forms known to the writer. The following key has been proved

accurate by rearing all but *ovatus*, and examining numerous larvae. When using the key, it is necessary to have a clear understanding of long and short setae.

SPECIFIC SYNOPSIS

1. Seta I of scuto-scutellum (sc-scl) and scutellum (scl) long, much longer than II, as long as III, both preepipleurum (ea) and epipleurum (e) of last two thoracic segments with a long seta *ovatus* Linn.
1. Seta I of scuto-scutellum and scutellum short, at most slightly longer than II; only meso- and metapreepipleurum with a prominent seta, epipleura with minute setae 2
2. Setae on dorsum of ninth segment at points of a triangle, apex forward; seta II of eighth segment very short, minute, rather anterior 3
2. Setae on dorsum of ninth in a straight transverse line; second seta on scutellum of eighth not reduced 4
3. Setae all rather long and attenuate, short setae not stout and spine-like; sclerites of mentum not especially thickened.
sulcatus Fabr.
3. Setae shorter, the short setae quite stout and spinelike; sclerites of mentum notably thickened behind junction of cross pieces (see Fig. 19) *rugosostriatus* Goeze
4. Setae I and II of meta scuto-scutellum short, III long; pedal lobes with five prominent setae; setae more attenuate; ocellar pigment present *meridionalis* Gyll.
4. Seta I of metascuto-scutellum short, II long, III short; pedal lobes with six prominent setae; setae shorter especially caudad; no ocellar pigment apparent *cribricollis* Gyll

Brachyrhinus ovatus (Linn.)

(Strawberry Root Weevil)

(Figs. 12, 12A, 13, 13A, 14, 15, 16, 16A)

Length 8 mm. Body not tapering quite as much as in the four following species. Ocellar pigment absent; paragnaths with short spinules; sclerites of mentum not unusually thickened. Seta I on all segments long, much longer than II and as long as III or nearly so; I of metascuto-scutellum long, II rather short, III very long, IV moderately long; a prominent seta on meso- and metaepipleurum; pedal lobes with eight setae, five of which are prominent; integument discontinuously spinulate with dorsal spinules from the mesothorax to the eighth abdominal segment; scutellum of eighth with II short, no shorter

than IV, slightly anterior; each side of dorsum of ninth segment with three setae at the points of a triangle, apex forward.

Brachyrhinus ovatus is our smallest immigrant of the genus and is a very destructive strawberry pest which has not yet gained much of a foothold in California.

Known California distribution: Del Norte County. (Stragglers have been taken near San Jose and Los Angeles.)

Hosts in California: Privet, Strawberry.

Larvae are presumably to be taken in the early spring. No adults have been reared by the writer, the authentication going to Mr. J. Wilcox, who has bred many of these from Strawberry roots in Oregon.

Brachyrhinus sulcatus Fabr.

(Black Vine Weevil)

(Figures 24, 24A, 25, 25A, 26, 26A, 27, 28)

Length 13 mm. or more. Pigmented ocelli present and easily seen; spinules on ental side of maxillae and sides of hypopharynx (paragnaths) rather short; sclerites of mentum not thickened; seta I on all segments short; setae of metascuto-scutellum: I short, II long, III nearly as short as I, IV long; no prominent seta on thoracic epipleura; pedal lobes with seven setae, five prominent; integument partly spinulate, dorsum with spinules except sixth, seventh and eighth segments. All body setae distinctly and strikingly longer than those of *rugosostriatus*; scutellum of eighth with II minute, anterior; each side on dorsum of ninth with three setae at points of a triangle, apex forward.

This is our largest and most destructive imported species, though by no means the largest of the genus.

Distribution in California: general.

Hosts: a general feeder, the larvae are especially injurious to potted plants.

Larvae may be taken at various times of the year. A number of larval skins are correlated with adults.

Brachyrhinus rugosostriatus (Goeze)

(Rough Strawberry Root Weevil)

(Figures 17, 17A, 17B, 17C, 18, 18A, 19, 20)

Length 11 mm. Pigmented ocelli present; spinules on ental side of maxillae reduced in most cases to minute knobs, those on paragnaths distinctly longer; sclerites of mentum distinctly

thickened in the angles posterior to the junction of the crossed pieces; seta I on all segments short, the metascuto-scutellum as in *sulcatus*; no prominent seta on thoracic epipleura; pedal lobes with seven setae, five prominent; integument with spinules on some areas, apparently more or less present on dorsum of all segments; body setae shorter than *sulcatus*, the short ones especially stout and spine-like; scutellum of eighth and dorsum of ninth as in *sulcatus*.

Distribution in California: at various isolated points but gradually occupying the unattained localities.

Hosts in California: Strawberry to the north, but Privet, Coton-easter and other shrubs to the south.

Larvae may be found in the early spring, several rearings have established the identity of this species and linked the larva with the adult.

Brachyrhinus meridionalis Gyll.

(Figure 35)

Longest larvae examined 12½ mm. Pigmented ocelli present; spinules on ental side of maxillae reduced to knobs in most cases; spinules on paragnaths not as long as in *cribricollis*; sclerites of mentum not thickened; seta I short on all segments; seta II on metascuto-scutellum but slightly longer, III long, IV moderately long; no prominent seta on thoracic epipleura; pedal lobes with eight setae: three very minute, one quite short, leaving four long; integument not spinulate except in limited areas, the dorsal spinules much smaller than in *cribricollis*; dorsal and lateral abdominal setae longer than in *cribricollis*, especially caudad; scutellum of eighth with II no smaller than I, but slightly anterior; three setae in a transverse line on each side on dorsum of the ninth segment.

Known California distribution: Sacramento, Niles, San Jose, Menlo Park.

Hosts in California: Privet and Coton-easter.

Larvae may be taken as late as May 1. Adults have been reared and associated with larval skins.

Brachyrhinus cribricollis Gyll.

(The Roman or Cribrate Weevil)

(Figures 21, 22, 23, 36)

Length up to 12 mm. No pigmented ocelli; spinules on maxillae the same as *meridionalis* but those on paragnaths distinctly longer; sclerites of mentum not thickened; seta I on

all segments short; seta II of metascuto-scutellum long, III nearly as short as I, IV long; no prominent epipleural seta on thorax; pedal lobes with eight setae: two minute and six quite prominent; integument discontinuously spinulate, spinules dorsally from mesothorax to seventh abdominal segment, more noticeable than in *meridionalis*; dorsal and lateral abdominal setae not as long as in *meridionalis*; scutellum of eighth with II no shorter than I and not anterior to the line; three setae in a posterior row on each side on the dorsum of the ninth segment.

Distribution in California: various places in the Sacramento Valley; San Francisco Bay region; Los Angeles County; elsewhere.

Hosts in California: Privet, Olive, *Pyracantha* and others.

Larvae may be collected in the early spring. There is evidence to indicate that a second brood may occur. A number of adults have been reared and associated with larval skins.

Genus PERITELINUS Csy.

Head: orange-brown, rather heavily sclerotinized, slightly longer than wide from base of clypeus, fully exposed; frontal sutures present; a short hyaline area from the frontal suture, extending back to and including the prominent admedian epicranial seta (mes); frontal setae: one prominent and two minute, one minute seta absent; anterior epicranial setae eight in number, prominent except sd2 and one sublateral which are minute; no pigmented ocelli; antennae with large oval apical joint rather subglobular; epipharynx with five anterior marginal setae, the inner three well separated from each other and from those opposed; mandibles, when not worn, with two apical teeth; ental and outer side of maxillae with a few short spinules; basal joint of maxillary palpi as long as apical joint; sclerites of mentum complete, moderately thick, slight indications of thickening around junction; no subfacial spinules. Body white, cyrtosomatic, rather tapering to both ends, especially caudally; largest circumference central; posterior part of seventh and about all of eighth and ninth abdominal segments rather heavily sclerotinized; no extra prominent areas; setae rather stout, (distinctly stouter than in *Geoderces*), evenly tapering, stiffer ventrally, contrasting with body color and moderately long; tubercles when isolated rather small, but approximate setae usually on compound and rather large tubercles; skin spinules present dorsally and ventrally but in most cases rather small, discontinuous, blunt, and inconspicuous. Thorax: shield with eight setae, those along anterior margin with one isolated near middorsum, and three, near

each other, rather lateral; scuto-scutellar areas with I, II and IV medium length, III rather long, I somewhat remote, the remainder usually equidistant and on the same compound tubercle; alar areas with one long seta; meso- and metaepipleurum each with a medium length and two minute setae, both sclerotized as are also the preepipleura; mesoepipleurum somewhat distinct from mesopreepipleurum, metaepipleurum quite distinct; pedal lobes with six prominent and one minute seta. Abdomen: scutellum of first seven segments with I short, II slightly shorter, III and V long, IV as II; epipleural and hypopleural areas with two prominent setae each; eusternal setae of equal length. Scutellum of eighth with II considerably anterior to I and III, III usually though not invariably closer to I than to IV, V doubtfully present (though indicated), at least not on the same sclerotization with the others and occupying usual position of large alar seta; pleurum as preceding segments. Three setae on dorsal lobe of ninth segment occupying points on an inwardly oblique line; lateral lobe with a long and a minute seta above; eusternal setae of ninth unlike previous setae, very heavy, set close together and subparallel, of nearly equal length; tenth segment terminal, membranous, and with minute setae only. Spiracles rather small, circular, all bifore, mesothoracic largest, air-tubes apparently with indications of annulations on part of spiracles and projecting at least half their length beyond atrium.

Peritelinus variegatus Casey

(Figure 37, 37A)

This genus is monospecific. The larva is about $6\frac{1}{2}$ to 7 mm. long when full grown.

Distribution in California: common in the lower Sierras east of the Sacramento Valley, also probably found on the west side of the Valley.

Hosts: larvae and adults have been taken from various species of *Ceanothus*, notably *cuneatus*; a number of different kinds of shrubs are undoubtedly fed upon; adults are at times injurious to leaves on fruit trees.

Larvae are present up to the middle of April. A number of adults have been reared and associated with larval skins.

This genus is very close to the following in larval form. The absence of one minute seta from each side of the frons is noteworthy as the usual four setae (including the long one) are found on all other genera here described except *Mesagroicus*. The absent seta in the case of *Peritelinus* seems to be the third (second minute),

although the first minute seta has been noted in one case to approximate the position of the lost seta. This seta has been lost without a reduction of the frons in either case.

The position of A8-III is only partly useful as a distinguishing character. Thus on the same larva it has been observed to be nearer I on one side and nearer IV opposite. No *Geoderces* has been seen, however, on which A8-III is nearer I than IV.

Genus GEODERCES Horn.

Head orange-brown, fairly heavily sclerotinized, not much longer from base of clypeus than wide, fully exposed; frontal sutures present, somewhat widened just above the large sutural seta; no longitudinal hyaline area on epicranium; frons with one prominent and three minute admedian setae; anterior epicranial setae of eight members, the second submedian and one sublateral minute; no pigmented ocelli; apical antennal segment comparatively large, oval, subglobular; epipharynx with five anterior marginal setae and three internal setae rather widely separated from those opposed; mandibles, when not worn, with two apical teeth; ental side of maxillae with a few short spinules, apparently none outwardly; basal joint of maxillary palpus as long as apical joint; sclerites of mentum complete, somewhat thickened at junction; no spinules on subfacial area. Body white, cyrtosomatic, rather tapering from middle and with posterior part of seventh and most of eighth and ninth segments largely sclerotinized, but no extra prominent areas, thickest at first part of abdomen; setae somewhat stout, regularly tapering, conspicuous; setiferous tubercles rather large, tending to be confluent when approximate; comparatively few skin spinules. Thoracic shield with eight setae; highest of the four on front margin isolated. Meso- and meta-scuto-scutellum similar: I, II and IV medium length, III long; I furthest separated; II and III usually closest, most often on same compound tubercle, which may include IV; alar areas of these segments with a long seta. Meso- and metaepipleurum with a medium length and two minute setae, separated on each segment from preepipleurum, though more distinct on meta-thorax, all these areas somewhat sclerotinized; pedal lobes with six prominent setae and one minute seta. Scutellum of first seven abdominal segments with I, II and IV short, III and V long; epipleural areas with a long and a rather short seta; hypopleural areas the same as the epipleura; eusternal setae of equal length. Eighth segment with II much anterior to usual line, III equidistant between I and IV or nearer IV, V doubtfully present (though indicated), at least not on same

sclerotization as IV; pleural areas as the preceeding. Dorsum of ninth with a large central sclerotized lobe, somewhat prominent, and with three setae on an inwardly oblique line; lateral lobes with dorsad long seta and a minute seta; sternal setae of ninth segment close, equidistant, very stout and subparallel, moderate length; tenth segment terminal, membranous and with only minute setae. The spiracles either all bifore, part bifore and unifore, or air-tubes entirely absent; in one case the air-tubes show slight annulations.

Three species of *Geoderces* have been examined but no specific determinations are now available. They are all very uniform in structure.

SYNOPSIS OF SPECIES

- Spiracles all bifore, mesothoracic with traces of annulations on the air-tubes Species No. 1
 Spiracles of mesothorax bifore, the remainder unifore or air-tubes wanting.....Species No. 2 (near *puncticollis* Csy.)
 Spiracles entirely lacking air-tubes Species No. 3

Species No. 1

(Fig. 34)

Length 8 mm. (probably not full grown).

Distribution in California: Del Norte County.

Host: Strawberry.

This species is known only from a single larva which fits very well with the two following. No rearings have been made.

Species No. 2

(near *puncticollis* Casey)

(Figures 29, 29A, 30, 31, 32, 32A, 33)

Length when ready to pupate $6\frac{1}{2}$ mm. The spiracles that are bifore or unifore show no annulations on the air-tubes; most of abdominal spiracles without air-tubes.

Distribution in California: Santa Clara County.

Host: destructive to Strawberries.

Larval skins have been associated with adults through rearing. This is a small species.

Species No. 3

Length $6\frac{1}{2}$ mm. The lack of air-tubes on any of the spiracles seems to be the only difference between this and No. 2.

Distribution in California: Sierras at middle elevations.

Hosts: *Ribes* and herbs.

Adults are correlated with larvae by rearing.

The *Geoderces* larva differs from the *Peritelinus* larva mainly in four ways: 1. *Geoderces* possesses four setae on each side of the frons; *Peritelinus*, three setae. 2. The absence of a hyaline area in *Geoderces* is relative, as a widened place occurs in the frontal suture just beyond the sutural seta, which is definitely correlated with the structure of *Peritelinus*. 3. The setae of *Geoderces* are distinctly more slender. 4. Seta A8-III, which may be nearer IV than I, or half way between, has never been noted as nearer I. In *Peritelinus*, however, this seta (as has been stated) may exceptionally be nearer IV, making this distinction rather poor.

An unidentified larva possesses characters found in both *Peritelinus* and *Geoderces*. It has a narrow hyaline band on the head, much as that of the former genus, but the spiracles lack air-tubes as on one species of *Geoderces*.

Genus SITONA Germ.

(Figures 50, 51)

This genus would not appear from larval form to be an Otiorynchid, but it has interesting transitional characters. These have been stated in the synopsis at the beginning of this paper. The presence of a median frontal carina, and spiracles of a type not yet found in the *Otiorynchinae* would seem to definitely exclude this genus from that subfamily, on larval characters. (The larvae of *Trypopermnon* available to the writer have bifore spiracles but the air-tubes are shorter and lack the annulations shown by Pierce 6.) The head has a narrow hyaline band on the epicranium (not the Otiorynchid style) and none of the setae normally minute are changed. The presence of frontal sutures should be noted. (For that matter, all the characters would place this genus in the frontal suture group should it be classified as an Otiorynchid.)

The body setae are not reduced in any unusual ways. Scutellar I is long. There are a few skin spinules.

The writer has had the opportunity to examine the larva of *Sitona hispidula* Fab. through the courtesy of Mr. H. H. Ross and J. H. Bigger of the Illinois Natural History Survey.

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EXPLANATION OF SYMBOLS

- a—alar area
- A₁—A₁₀—abdominal segments
- adm—admedian epicranial seta
- ant—antenna
- at—air-tubes of spiracle
- atr—atrium of spiracle
- cl—clypeus
- cx—pedal lobes of thorax, parasterna of abdomen
- e—epipleurum
- ea—preepipleurum
- ep—epicranium
- eps—epicranial suture
- eu—eusternum
- f—frons
- fs—frontal suture
- hp—hypopleurum
- I, II, III, IV and V—setae of scuto-scutellum and scutellum
- l₁—l₂—first and second lateral head setae
- lbr—labrum
- ln—ligula
- m—sclerites of mentum
- mfc—median frontal carina
- mfs—admedian frontal setae
- mx—maxilla
- mxp—maxillary palpus
- o—opening of spiracle
- oc—ocelli
- pes—posterior epicranial setae
- post—poststernellum
- pse—prescutum
- psel—postscutellum
- sc—scutum
- sel—scutellum
- sc-sel—scuto-scutellum
- sep—lateral epistomal seta
- sl₁—first sublateral head seta
- sm₁, sm₂, sm₃—first, second and third submedian epicranial setae
- sp—spinules
- ss—sutural seta
- T₁, T₂, T₃—Thoracic segments

PLATE XXI

Dyslobus decoratus Lec.

- Fig. 1 Front view of head with mandibles removed, showing hyaline bands.
- Fig. 1A Antenna as seen from above.
- Fig. 2 Left side of head and two thoracic segments.
- Fig. 2A Mesothoracic spiracle.
- Fig. 3 Left side of second abdominal segment.
- Fig. 3A Spiracle of second abdominal segment.
- Fig. 5 Detail of dorsum of ninth abdominal segment to show spinule arrangement.
- Fig. 6 Caudal view of last three abdominal segments.
- Fig. 6A Eighth abdominal spiracle.

Dyslobus ursinus (Horn.)

- Fig. 4 Detail of left side of dorsum of ninth abdominal segment, showing spinule arrangement.

Dyslobus granulatus Casey

- Fig. 7 Caudal view of last three abdominal segments
- Fig. 7A Mesothoracic spiracle.

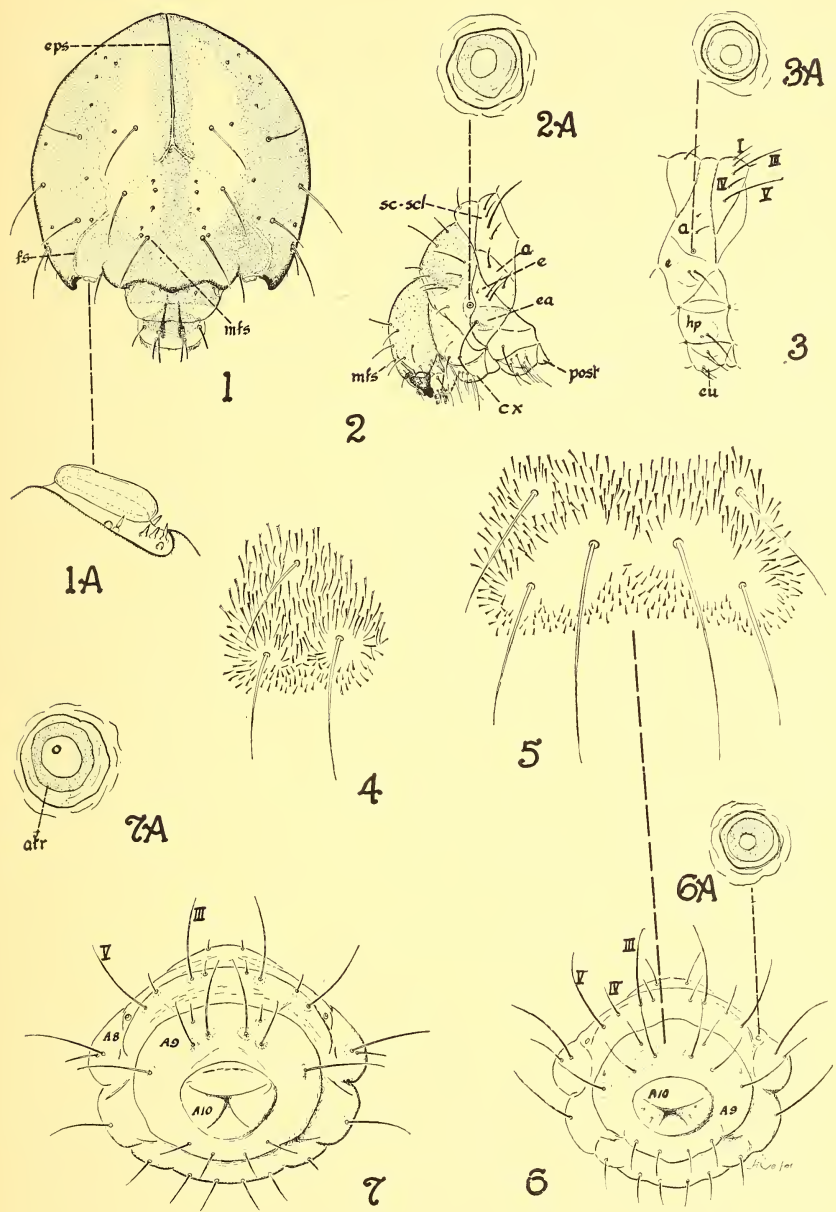


PLATE XXII

Pantomorus godmani

- Fig. 8 Diagram of larva, left side.
- Fig. 8A Mesothoracic spiracle.
- Fig. 8B Second abdominal spiracle.
- Fig. 8C Eighth abdominal spiracle.
- Fig. 9 Front view of head with mandibles removed.
- Fig. 10 Maxilla and general suboral area from below.
- Fig. 10A Ental view of maxilla showing spinules.
- Fig. 11 Caudal view of last three abdominal segments.

Brachyrhinus ovatus

- Fig. 12 Left side of head and first two body segments.
- Fig. 12A Mesothoracic spiracle.
- Fig. 13 Left side of second abdominal segment.
- Fig. 13A Second abdominal spiracle.
- Fig. 14 Deformed mesothoracic spiracle.
- Fig. 15 Ligula and sclerites of mentum.
- Fig. 16 Caudal view of last three abdominal segments.
- Fig. 16A Eighth abdominal spiracle.

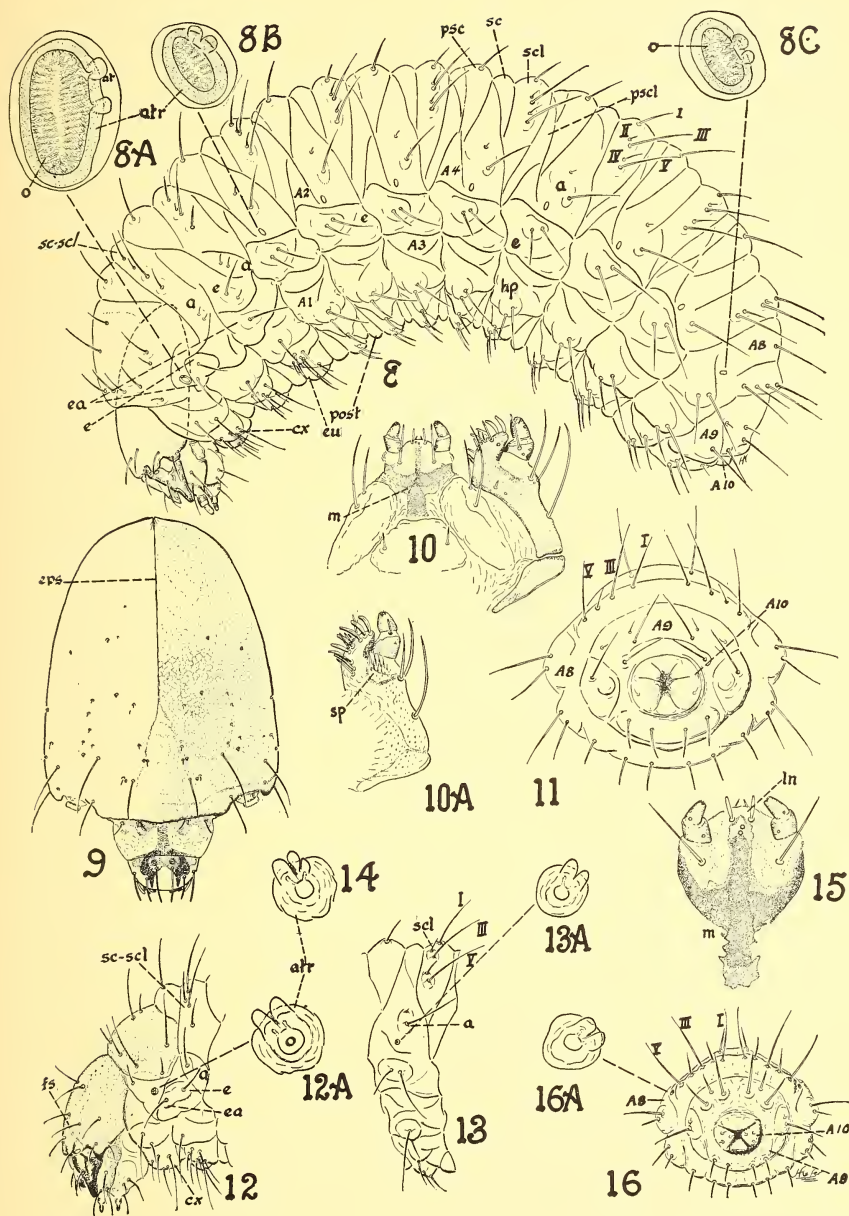


PLATE XXIII

Brachyrhinus rugosostriatus

- Fig. 17 Larva, left side.
- Fig. 17A Mesothoracic spiracle.
- Fig. 17B Second abdominal spiracle.
- Fig. 17C Eighth abdominal spiracle.
- Fig. 18 Front view of head with mandibles removed.
- Fig. 18A Antenna, front view.
- Fig. 19 Ligula and sclerites of mentum.
- Fig. 20 Caudal view of last three abdominal segments.

Brachyrhinus cribricollis

- Fig. 21 Ligula and sclerites of mentum.
- Fig. 22 Mesothoracic spiracle.
- Fig. 23 Caudal view of last three abdominal segments.

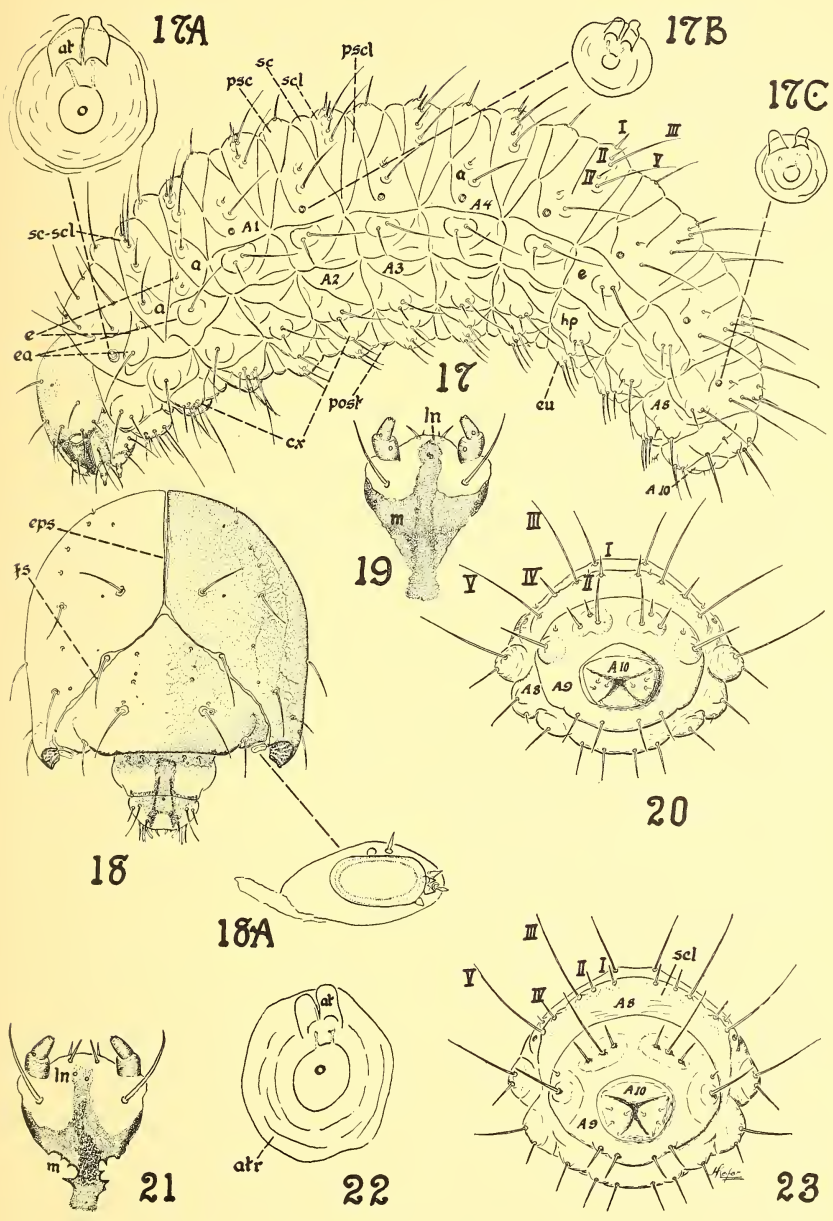


PLATE XXIV

Brachyrhinus sulcatus

- Fig. 24 Left side of head and two body segments.
- Fig. 24A Mesothoracic spiracle.
- Fig. 25 Left side of second abdominal segment.
- Fig. 25A Second abdominal spiracle.
- Fig. 26 Caudal view of last three abdominal segments.
- Fig. 26A Eighth abdominal spiracle.
- Fig. 27 View of general subfacial area and left maxilla.
- Fig. 28 Ental view of right maxilla.

Geoderces sp. No. 2

- Fig. 29 Left side of first two thoracic segments.
- Fig. 29A Mesothoracic spiracle.
- Fig. 30 Antenna, as seen from above.
- Fig. 31 Second abdominal spiracle.
- Fig. 32 Caudal view of last three abdominal segments.
- Fig. 32A Eighth abdominal spiracle.
- Fig. 33 Deformed mesothoracic spiracle.

Geoderces sp. No. 1

- Fig. 34 Mesothoracic spiracle.

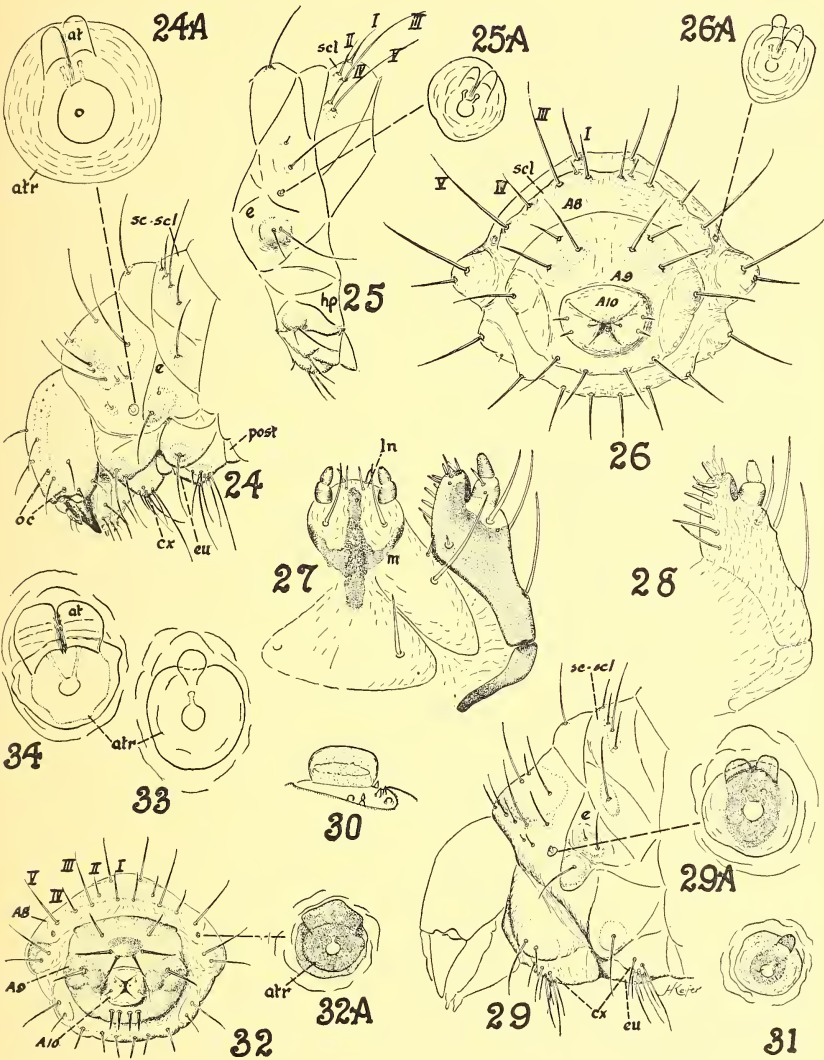


PLATE XXV

Brachyrhinus meridionalis Cyll.

Fig. 35 Left side of thorax and first abdominal segment.

Brachyrhinus cribricollis Gyll.

Fig. 36 Left side of last two thoracic segments and first abdominal.

Peritelinus variegatus Csy.

Fig. 37 Head with mandibles removed.

Fig. 37A Mesothoracic spiracle.

Trigonoscuta pilosa Mots.

Fig. 38 Left side of head, thorax, first abdominal segment.

Fig. 38A First abdominal spiracle.

Fig. 38B Mesothoracic spiracle.

Fig. 39 Left side of last four abdominal segments.

Fig. 39A Eighth abdominal spiracle.

Fig. 40 Caudal aspect of last four abdominal segments.

Fig. 41 Maxilla, labium, and subfacial area.

Fig. 42 Head, mandibles removed.

PLATE XXVI

Mesagroicus sp.

- Fig. 43 Head with left mandible removed.
Fig. 44 Left side of entire larva.
Fig. 44A Mesothoracic spiracle.
Fig. 45 Caudal aspect of larva.
Fig. 46 Ventral view of suboral structures and of maxillae.

Rhyncagonus extraneus Perk.

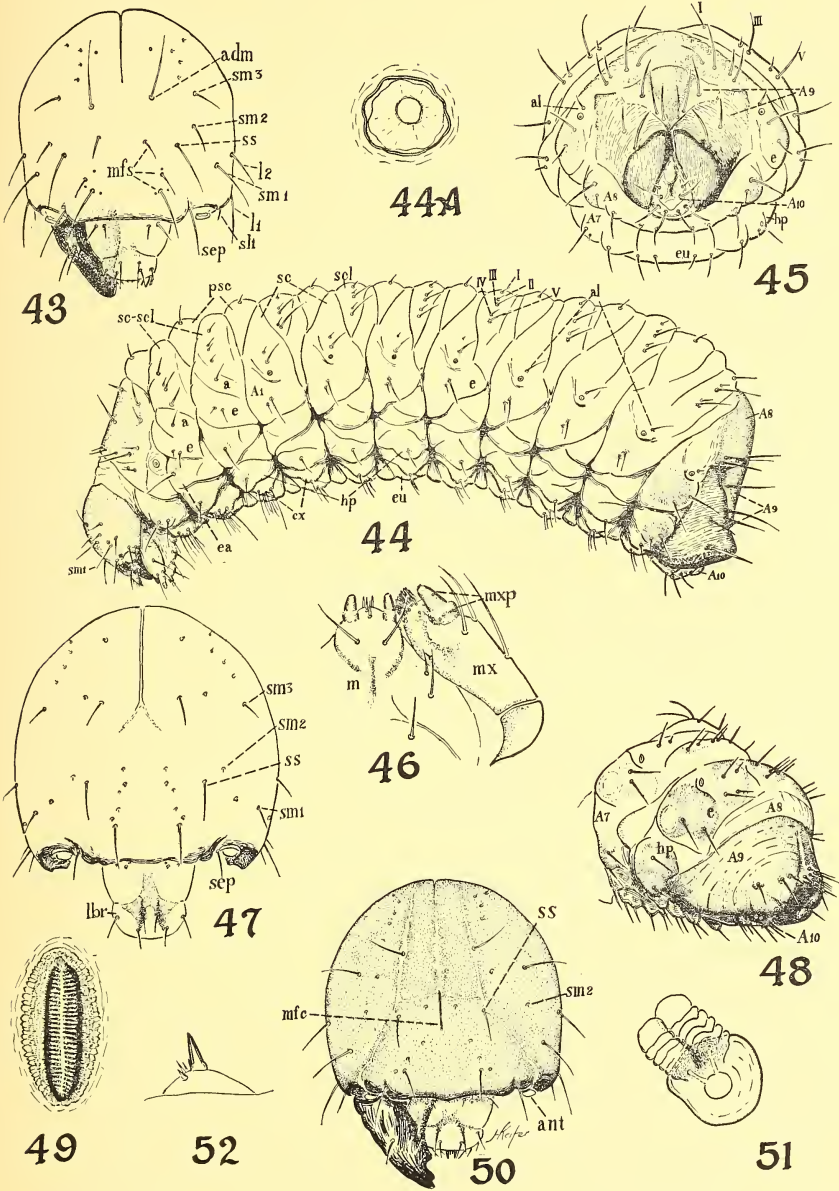
- Fig. 47 Head with mandibles removed.
Fig. 48 Caudo-lateral view of last four abdominal segments.
Fig. 49 Mesothoracic spiracle.

Sitona hispidula Fabr.

- Fig. 50 Head without left mandible.
Fig. 51 Mesothoracic spiracle (right).

Hypera punctata

- Fig. 52 Antenna.



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THE NEARCTIC SOCIAL WASPS OF THE SUBFAMILY POLYBIINAE (HYMENOPTERA; VESPIDAE)

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The so-called social wasps of the New World are now placed in three subfamilies, *viz.*, the Vespinae, Polistinae, and Polybiinae. These three groups are so distinct, structurally, that I must regard them as forming at least as many genealogical lines, each of them derived from its own ancestral stock of solitary wasps. Whatever similarity in habits they now exhibit is solely due to convergence and caused by the unavoidable reaction of communal life upon individual behavior.

In the New World, the Vespinae are restricted to North America, where they are represented by a number of species of the Holarctic genus *Vespula* (and one introduced *Vespa*). I have recently published a revision of these wasps. The Polistinae are a cosmopolitan group consisting of a single genus, *Polistes*, with many, rather closely allied, species. In the Nearctic Region this genus comprises not more than half a dozen species distinguishable by peculiarities of structure; but some of these species vary tremendously in color. Contrasting with the foregoing two groups, the Polybiinae are essentially a tropical subfamily. They are especially numerous in the American tropics, where they offer so much variety in structure and habits, that one may well raise the question whether they are not a composite, or polyphyletic, group.

Only three species of Polybiinae are known to occur within the political boundaries of the United States, and only one of these extends into the Dominion of Canada. Two genera only, *Nectarina* and *Mischocyttarus*, are represented, and it is important to note at once that these genera have many representatives in the Neotropical Region. Moreover, of the three species, only one (*M. flavitarsis*) is a precinctive Nearctic insect; a second species (*M. cubensis*) is a West Indian wasp that has invaded the southeastern United States; while the third (*N. lecheguana*) is a common and widely distributed South and Central American insect that barely crosses the Mexican border into Arizona and Texas. It would therefore seem that the Polybiine fauna of the Nearctic Region is unquestionably of Neotropical origin. At least two of the three species most probably extended their range into Nearctic territory after the close of the last Glacial Period.

KEY TO NEARCTIC GENERA

- Third and fourth segments of mid and hind tarsi with the inner lobe produced and decidedly longer than the outer lobe. Body long and slender, the abdomen much narrowed at the base; first segment stalk-like. Scutellum and postscutellum forming one continuous slope. Eyes bare *Mischocyttarus*.
- Third and fourth segments of mid and hind tarsi with the inner and outer lobes equally developed. Body short and stubby, the abdomen broadly rounded off at base; the first segment not stalk-like, very short and flattened against the much broader second segment. Scutellum mostly horizontal, its hind portion forming a protruding ledge over the vertical postscutellum. Eyes pubescent *Nectarina*.

Mention should be made here of *Polybia saussurei* A. E. Holmgren (1868, Kongl. Svenska Freg. Eugenies Resa, Vet. Iakt., II, Zool., 1, Insecta, Hym., p. 440; ♀ ♂), described from "California et Puna." So far as I was able to discover, this insect has not been recognized since, although the types are in the Stockholm Museum. The description does not mention the characters needed to place it in one of the modern genera of Polybiinae. It is not impossible that it is a *Mischocyttarus*, but the coloration and small size (length, 8 to 10 mm.) exclude *M. flavitarsis* and the size is even too small for *M. cubensis* var. *mexicanus*. In any case, the locality "California" must have been due to an error in labelling the specimens. No wasp even remotely like the description of *P. saussurei*

has since been taken in the western United States.¹ The conclusion seems therefore warranted that the type locality of *P. saussurei* was the island of Puna, in the Gulf of Guayaquil, Ecuador.

Nectarina Swainson and Shuckard

Brachygastra Perty, 1833, Delectus Anim. Articul. Brasil., p. 145 (for two species: *Brachygastra analis* Perty, 1833, and *B. scutellaris* Perty, 1833; type by present designation: *Brachygastra analis* Perty = *Polistes lecheguana* Latreille, 1824). Not *Brachygaster* Leach, 1815.²

Brachygaster H. de Saussure, 1852, Et. Fam. Vesp., I, p. 171, footnote (misspelling of *Brachygastra* Perty).

Nectarina Swainson and Shuckard, 1840, On the History and Natural Arrangement of Insects, p. 183, footnote (substitute for *Brachygastra* Perty, 1833;³ type by designation of Ashmead, 1902, Canad. Entom., XXXIV, p. 165: *Brachygastra analis* Perty, 1833 = *Polistes lecheguana* Latreille, 1824). Not *Nectarinia* Illiger, 1811.

Nectarinia H. de Saussure, 1853–1855, Et. Fam. Vesp., II, p. 225 (misspelling of *Nectarina* Swainson and Shuckard).

Melissaia Shuckard, 1841, in White, Ann. Mag. Nat. Hist., VII, p. 320, footnote (substitute for *Nectarina* Swainson and Shuckard, 1840).

Caba R. von Ihering, 1904, Rev. Mus. Paulista, VI, pp. 103 and 105 (substitute for *Nectarina* Swainson and Shuckard, 1840).

Generic Characters.—Body thickset. Head broad and short; eyes covered with short, scattered hairs, more numerous in the upper half; inner orbits distinctly but moderately

¹ The Frigate *Eugenie* called at many ports on the west coast of South and North America. But in California the Expedition visited only San Francisco. So much collecting has been done near that city, that *P. saussurei* could hardly have escaped notice since 1868.

² If *Nectarina* and *Nectarinia* are both regarded as valid names, as well as *Polybia* and *Polybius*, there seems to be no reason why *Brachygaster* Leach and *Brachygastra* Perty should be treated as homonyms. In view of the general use of *Nectarina*, I feel, however, reluctant to return to the oldest generic name of the honeywasps.

³ The name should be credited to Swainson and Shuckard jointly, since the footnote uses “we” and is not signed with Shuckard’s initials (see introductory note of the “History and Natural Arrangement of Insects”).

emarginate; ocelli normal; oculo-malar space short, rudimentary or absent; genae broad, separated from the postgenae by a strong carina which reaches the base of the mandibles and continues behind the vertex; clypeus short, its lower portion broadly triangular and bluntly rounded off at apex; mandibles rather narrow, the apical or cutting edge oblique and with four unequal teeth; maxillary palpi 6-jointed; labial palpi 4-jointed, the apical segment without erect inner seta. Antennae of 12 segments in female and worker; of 13 segments in male, all the segments normal. Thorax short and thick, cubic; anterior margin of pronotum truncate, dorsally with a raised rim which stops at or slightly below the humeri, where it forms right angles; mesonotum without notauli; scutellum very large, wider than long; its median portion with an anterior, horizontal area and a posterior, vertical portion, the two separated by a raised edge or ridge, usually somewhat concave in the middle; postscutellum (true metanotum) vertical, its posterior margin a deep, transverse, straight groove, which divides it from the propodeum as well as from the median propodeal area; postscutellum in a plane with the hind portion of the scutellum and hidden (when viewed from above) by the more or less protruding transverse edge of the scutellum; propodeum very short, its sides swollen and with a raised ridge or a strong angle, its median portion vertical and slightly concave, at the base with a distinct median, cordate area;⁴ valvae surrounding the retractor muscle low, forming a broadly oval dorsal orifice; mesopleura without even a trace of mesepisternal suture and without epinenial suture; mesepimeral suture obsolete or very slightly developed. Abdomen short and broad, globular, consisting mostly of the very large, swollen, bell-shaped second segment, in which the succeeding segments may be almost completely retracted; first tergite very short, much narrower than the second, scale-like and flattened against the second tergite, its narrow base, articulating with the propodeum, very short, not stalk-like, its spiracles more or less prominent, placed close to the hind margin; second sternite shorter than the second tergite, abruptly sloping at the base; sting strongly barbed. Legs rather short, of normal shape; lateral lobes of tarsal segments and claws symmetrical; mid tibiae with two apical spurs. Wings short; venation of the usual vespid type; fore wing:

⁴ A comparative study of the postscutellum and base of propodeum in the Vespidae seems to indicate that this "basal area" of the propodeum was originally part of the postscutellum and homologous with the produced hind portion which in Vespinae and in *Protopolybia* is wedged in the base of the propodeum, from which it is distinctly divided.

basal vein ending close to the stigma; radial cell much narrowed and pointed in its apical half; second cubital cell narrow, always much higher than wide; hind wing with few hooks (6 to 9), a broad but rather short basal (or posterior) lobe, and a distinct preaxillary excision; discoidella leaving the nervellus at about the upper third, far below the origin of the cubitella. The males differ from the queens and workers mainly in the narrower head and the elongate clypeus. Externally queens and workers are alike, though the former are slightly larger, with more swollen abdomen. H. von Ihering (1896), upon examining a number of females of *N. lecheguana*, found that in some the spermatheca was rudimentary and these he regarded as workers.⁵

Taxonomy.—*Nectarina* contains seven species separable by structural peculiarities, viz., *N. augusti* (H. de Saussure), *N. azteca* (H. de Saussure), *N. baccalaurea* (R. v. Ihering), *N. bilineolata* (Spinola), *N. buyssoni* Ducke, *N. lecheguana* (Latreille), and *N. scutellaris* (Fabricius). I have seen specimens of all.⁶ They differ mainly in the shape of scutellum and propodeum, the sculpture, and the development of the oculo-malar space (this is much longer in *N. bilineolata* than in most of the other species). Each species appears to have a more or less characteristic color pattern, although some of them show a fairly pronounced geographical variation in color.

Distribution.—The genus *Nectarina* is one of the most typical elements of the Neotropical fauna. It extends from southern Arizona (northernmost locality: Nogales, in about 32° lat. N.) to northern Argentina (southernmost locality: Buenos Aires, in about 35° lat. S.); it is not known to occur within the political boundaries of Chile and is entirely absent from the Antilles, though quite common in Yucatan and Trinidad. One of the species (*N. lecheguana*) covers the whole of this territory, but the others are much more restricted in distribution. *N. azteca* is known only from southern

⁵ R. du Buysson's account of the morphology of *Nectarina* (1905, Ann. Soc. Ent. France, LXXIV, pp. 540–542, Pls. XI–XII), although quite extensive and well illustrated, does not mention some of the most important features of the genus, nor does it point out those that are diagnostic.

⁶ *Nectarina championi* Dover, 1925, Psyche, XXXI, (1924), p. 305, fig. 1 (♀), from Chiriquí, Panama, is not a *Nectarina*, as I suspected from the description. Paratypes kindly sent to me by Mr. Hugh Scott show that it is a *Parachartergus*, related to *P. frontalis* (Fabricius), though quite distinct.

Mexico (States of Tepic, Michoacán, México, Puebla, Guerrero and Oaxaca). *N. baccalaurea* is a species of the Andes of Peru and Ecuador (at about 1,600 m. altitude). *N. buyssoni* is known from only a few places on the Upper Amazon and Madeira Rivers (Tabatinga in Brazil; Iquitos in Peru; I have seen a specimen from Tumupasa, Bolivia). *N. augusti* and *N. bilineolata* have much the same distribution, being known from Guatemala to southern Brazil and Paraguay. *N. scutellaris* is strictly South American (from Colombia to São Paulo, Brazil). Four of the species occur in North America, one of them being endemic there.⁷

Ethology.—The nests are known of *N. augusti*, *N. azteca*, *N. bilineolata*, *N. scutellaris* and *N. lecheguana*. They agree in their general architecture, although each species shows certain definite building characteristics. The nest is aerial, entirely made of paper or cardboard and of the “phragmocytтарous” type, consisting of few combs (usually less than ten) of hexagonal cells enclosed in an envelope (calyptodomous), with one or more openings for ingress and egress; the first comb is attached directly to the support by its whole under surface and the succeeding combs are built on the lower surface of the envelope and later enclosed by lateral extension of the cover. In conical nests, the several combs are placed one above the other; in spherical nests they are more or less concentric. The entrance is either circular or slit-like and generally placed on one of the lower sides, the holes in the successive combs being also more or less eccentric. All five species mentioned above are polygynous, the nest containing several fertile, ovipositing females (queens). A new nest is started by a swarm leaving an old colony; and since the swarm contains several queens, in addition to many workers, these wasps are typically pleometrotic. So far as known, all species store honey, often in large quantities, which perhaps helps the colony to survive through the winter or dry season, so that the nest may persist for several years. Moreover, so far as published observations go, it would seem that the larvae of *Nectarina* are fed exclusively or mainly with honey and pollen.

Nectarina lecheguana (Latreille)

Text Figure 1. Plates XXVII and XXVIII

Polistes lecheguana Latreille, 1824, Mém. Mus. Hist. Nat., Paris, XI, p. 317 (♀; Brazil, without more definite locality; holotype in

⁷ I have seen *N. bilineolata* from Tegucigalpa, Rep. Honduras, and *N. augusti* from Columbian Farm, Sta. Clara Prov., Costa Rica.

- Paris Museum); 1825, Ann. Sc. Nat., IV, p. 339. Aug. de St. Hilaire, 1825, Mém. Mus. Hist. Nat., Paris, XII, Pl. XII, fig. B; 1830, Voyage dans les Provinces de Rio de Janeiro et de Minas Geraes, II, p. 375, footnote.
- Vespa lecheguana* Swainson and Shuckard, 1840, On the History and Natural Arrangement of Insects, p. 183.
- Polistes (Brachygastra) lecheguana* White, 1841, Ann. Mag. Nat. Hist., VII, p. 319, footnote.
- Epipone lecheguana* Curtis, 1844, Proc. Linn. Soc. London, I, No. 20, p. 188; 1844, Trans. Linn. Soc. London, XIX, pt. 3, p. 258.
- Nectarinia lecheguana* H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 232, Pl. XXX (nest, described on p. cxxxiv) and Pl. XXXIV, figs. 1, 1a-c, 3 and 3a-c (♀ ♀). Dalla Torre, 1894, Cat. Hym., IX, p. 170. Fox, 1898, Proc. Ac. Nat. Sci. Philadelphia, p. 460. Holmberg, 1898, Segundo Censo Republ. Argentina, I, p. 590. Schrottky, 1902, An. Mus. Nac. Buenos Aires, (3) I, p. 116; 1903, An. Soc. Cient. Argentina, LV, p. 179. Brèthes, 1903, An. Mus. Nac. Buenos Aires, (3) II, p. 16. Cockerell, 1927, Proc. U. S. Nat. Mus., LXXI, Art. 12, p. 2.
- Nectarina lecheguana* F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 136; 1863, Trans. Ent. Soc. London, (3) I, pp. 501-503; 1864, *Loc. cit.*, (3) II, p. 135. Dalla Torre, 1904, Gen. Ins., Vesp., p. 86. R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIV, pp. 542, 547 and 558, Pl. XI, figs. 1-7; Pl. XII, figs. 1-3, 6-8, 10 and 13; Pl. XV; and Pl. XVI (♀ ♂ ♂). Brèthes, 1906, An. Mus. Nac. Buenos Aires, (3) VI, p. 313. Ducke, 1906, Rev. d'Entom., Caen, XXV, p. 6; 1907, Bol. Mus. Goeldi (Pará), V, pp. 155 and 157; 1908, Rev. d'Entom., Caen, XXVII, p. 84. Schrottky, 1908, Zeitschr. Wiss. Insektenbiol., IV, pp. 24 and 52; 1909, *Loc. cit.*, V, pp. 210 and 212. Ducke, 1910, Ann. Mus. Nat. Hungarici, VIII, pp. 479 and 481 (♀ ♂). R. du Buysson, 1910, Zool. Jahrb., Abt. Syst., XXIX, p. 231. A. de W. Bertoni, 1911, An. Mus. Nac. Buenos Aires, (3) XV, p. 115. Meade Waldo, 1911, Ann. Mag. Nat. Hist., (8) VII, p. 111; 1914, *Loc. cit.*, (8) XIV, p. 406. Rohwer, 1914, Proc. U. S. Nat. Mus., XLVII, p. 513. Ducke, 1916, Comm. Linhas Telegr. Estrat. Matto Grosso, Publ. No. 35, Ann. No. 5, Hym., p. 7; 1918, Rev. Mus. Paulista, X, p. 327. Bodkin, 1918, Trans. Ent. Soc. London, (1917), pts. 2-4, p. 309. Bradley, 1921, Actes Soc. Scientif. Chili, XXX, (1920), p. 57. Pellett, 1922, Science, LV, p. 644. Dover, 1925, Psyche, XXXI, pt. 6, (1924), p. 307. Fonseca, 1926, Rev. Mus. Paulista, XIV, (1925), p. 171. Stiles

- and Hassall, 1928, U. S. Publ. Health Serv., Hyg. Labor., Bull. 150, p. 396. H. F. Schwarz, 1928, Jl. New York Ent. Soc., XXXVI, p. 460; 1929, Natural History, New York, XXIX, p. 425. Salt and Bequaert, 1929, Psyche, XXXVI, p. 261.
- Caba lecheguana* R. v. Ihering, 1904, Rev. Mus. Paulista, VI, pp. 106, 109 and 233 (♀ ♂).
- Vespa sericea* Fabricius, 1804, Syst. Piezat., p. 266 (no sex; "in America meridionali"). Not *Vespa sericea* Olivier, 1791.
- Brachygastra sericea* Erichson, 1848, in Schomburgk, Reisen in Britisch Guiana, III, p. 590.
- Chartergus sericeus* Möbius, 1856, Abh. Naturw. Ver. Hamburg, III, p. 144, Pl. XVI. Dalla Torre, 1894, Cat. Hym., IX, p. 169; 1904, Gen. Ins., Vesp., p. 85.
- Brachygastra analis* Perty, 1833, Delectus Anim. Artic. Brasil., p. 146, Pl. XXVIII, fig. 6 (no sex given, but from the figure evidently ♀; State of Piahy, Brazil). Spinola, 1841, Ann. Soc. Ent. France, X, p. 127 (♀).
- Nectarina analis* in Swainson and Shuckard, 1840, on the History and Natural Arrangement of Insects, p. 183, footnote. F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 136; 1862, Trans. Ent. Soc. London, (3) I, p. 39. Dalla Torre, 1904, Gen. Ins., Vesp., p. 86.
- Nectarinia analis* H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 230 (♀). Dalla Torre, 1894, Cat. Hym., IX, p. 169.^s
- Caba analis* R. v. Ihering, 1904, Rev. Mus. Paulista, VI, pp. 107 and 113.
- Polistes mellifica* Say, 1837, Boston Jl. Nat. Hist., I, pt. 4, p. 390 (♀ ♂; near Jalapa, Mexico); 1859, Complete Writings Entom., (Leconte's Ed.), II, p. 769 (♀ ♂).
- Nectarinia mellifica* H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 233 (♀ ♂), Pl. XXX bis (nest, described on pp. cxxix-cxxxiv). Dalla Torre, 1894, Cat. Hym., IX, p. 170. H. v. Ihering, 1896, Zoolog. Anz., XIX, p. 451; 1897, Ann. Mag. Nat. Hist., (6) XIX, p. 135. Kriechbaumer, 1900, Berlin. Ent. Zeitschr., XLV, p. 98.
- Nectarina mellifica* F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 137. W. A. Schulz, 1904, Berlin. Ent. Zeitschr., XLVIII, (1903), p. 262. H. S. Barber, 1928, Ent. News, XXXIX, p. 16.

^s Dalla Torre's reference "*Nectarinia analis* Guérin, Iconogr. règn. anim. VII. Insect. 1845 p. 148; T. 28 F. 6," is fictitious. Guérin does not mention or figure any species of *Nectarina*.

Gaba (*Nectarina*) *mellifica* H. S. Barber, 1905, Proc. Ent. Soc. Washington, VII, p. 25.

Nectarina mellifera Dalla Torre, 1904, Gen. Ins., Vesp., p. 86.

Nectarinia binotata H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 230 (♂; Cayenne). Dalla Torre, 1894, Cat. Hym., IX, p. 169.

Nectarina binotata F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 136. Dalla Torre, 1904, Gen. Ins., Vesp., p. 86.

Caba binotata R. v. Ihering, 1904, Rev. Mus. Paulista, VI, p. 107.

Nectarina lecheguana var. *binotata* R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIV, pp. 547 and 563 (♂).

Chartergus arizonaensis Cameron, 1907, Invert. Pacifica, I, pp. 181 and 182 (♀; Nogales, Arizona).

Chartergus centralis Cameron, 1907, Invert. Pacifica, I, pp. 181 and 182 (♀; Chinandega, Nicaragua; and Champerico, Guatemala).

Chartergus aztecus Cameron, 1906, Invert. Pacifica, I, p. 154 (♀; Mexico); 1907, *Loc. cit.*, I, p. 182. Not *Nectarinia azteca* H. de Saussure, 1857.

Nectarina cameroni Meade-Waldo, 1911, Ann. Mag. Nat. Hist., (8) VII, p. 112. New name for *Chartergus aztecus* Cameron, 1906.

The foregoing synonymy and references are of the typical form of the species.

Specific Characters.—*Queen and worker*.—Head of normal size and shape; seen in front, broadly oval and about as wide as high; seen from above, broadly rectangular and slightly more than twice as wide as long; occipital margin nearly straight. Carina bordering the genae not wavy, very slightly curved outward below the middle. Genae slightly wider than the eye in profile, of fairly uniform width throughout, not appreciably swollen and uniformly convex. Oculo-malar space very short, the upper mandibular condyle barely separated from the eye. Inner orbits about one and one-half times as far apart on the vertex as at the clypeus. Ocelli small, in a slightly flattened triangle; posterior ocelli about as far apart as from the inner orbits and slightly nearer the occipital margin. Eyes very distinctly pubescent; sinus broad and moderately deep. Vertex and face normal; interantennal area wide, almost flat, with the barest indication of a transverse and of an upper longitudinal ridge. Clypeus slightly and uniformly convex, broadly pentagonal, about one and one-half times as wide as long; its sides contiguous with the inner orbits over a short distance (about equal to the length of the second antennal segment); median lobe of anterior margin semi-elliptical, with

broadly rounded and blunt apex, divided by very shallow curves from the low lateral lobes. Mandibles moderately long, slightly over three times as long as wide, with subparallel sides; outer surface raised into a longitudinal convexity which runs from the upper mandibular condyle to the lower apical tooth; cutting edge very oblique, with four unequal teeth, increasing in size from the upper (or inner) to the lower one. Antennae: scape slender, slightly curved, about four and a half times as long as thick at apex and about as long as the four following segments together; second segment unusually large and swollen, nearly half the length of the third; third slightly less than the fourth and fifth together and about twice as long as wide; fourth slightly longer than wide; fifth about as long as wide; sixth to eleventh wider than long; twelfth distinctly longer than wide; flagellum very evenly swollen from the base to before the apex. Thorax as usual in the genus; carina of pronotum sharp, continuous across the middle of the anterior margin and ending at the humeral angles; humeri not prominent, not raised, placed slightly farther back than the middle of the pronotum when the thorax is seen from above. Division of the scutellum into an anterior, horizontal and a posterior, vertical area very sharp; the ridge between the two areas strong, although blunt, much protruding, nearly straight or more or less concave and sometimes slightly depressed or somewhat notched in the middle; horizontal area nearly flat, but with a conspicuous, depressed, smooth groove at the base, along the mesonotal suture; seen from above, the horizontal area is about twice as wide as long, nearly rectangular, although slightly narrower behind, ending laterally in blunt, right angles; vertical area about half the length of the anterior area, slightly concave transversely and with a fine, median, longitudinal depressed line; both the horizontal and vertical areas are abruptly divided from the somewhat concave sides, which extend to the base of the fore wing and are limited behind by a sharp carina. Median, vertical portion of post-scutellum flat, a little over three times as wide as long and nearly one and one-half times as long in the middle as the vertical area of the scutellum, distinctly shorter on the sides, where it forms at each upper angle a small, erect, blunt tooth, which is more or less strongly developed and sometimes barely indicated; the anterior margin evenly convex, the posterior margin straight; median area sharply set off from the concave sides, which extend to the base of the hind wings. Upper half of propodeum on each side with a broad, flattened, triangular ridge, quite blunt at apex, running from the spiracle to a short distance from the median concavity, forming distinct lateral

angles, which are variable in size and shape; below the angles the sides of the propodeum are evenly rounded. Second abdominal segment moderately swollen, passing by even curves into the basal slopes, seen from above slightly wider than long, in profile about as thick as long at the tergite. Integument shiny, the sculpture hidden to a large extent by the silky pubescence; punctures generally small; larger and denser on pronotum, pleura, sides of propodeum, and especially on the horizontal area of the scutellum; minute and scattered on abdomen; very sparse on clypeus and lower part of face; mandibles, vertical area of scutellum, postscutellum and concavity of propodeum impunctate. Pubescence very dense, grey, silky, especially striking in fresh specimens.

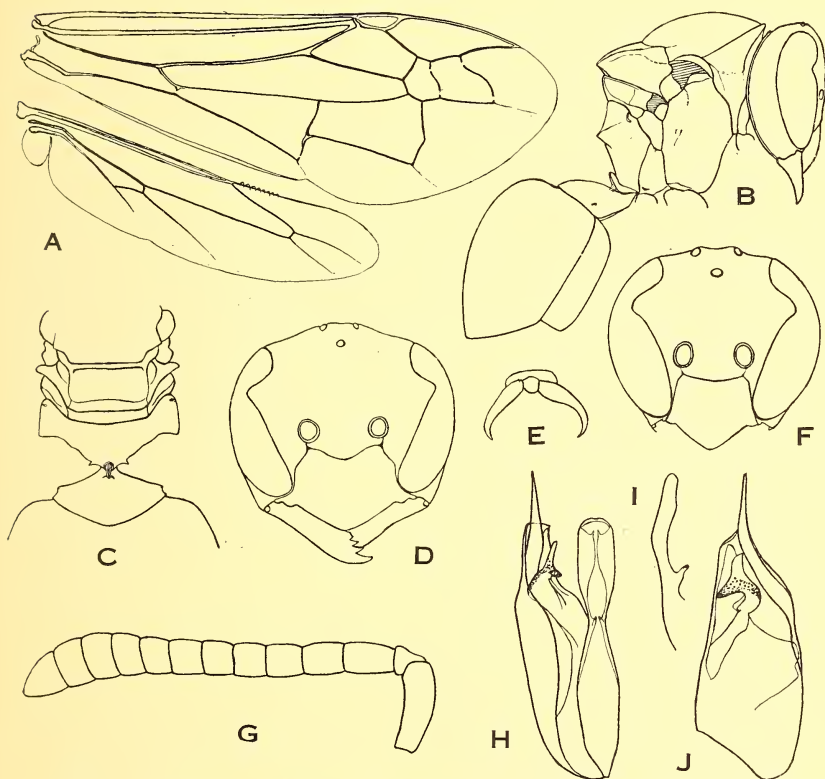


FIG. 1. *Nectarina lecheguana* (Latreille): A, wings of female; B, body of female in profile; C, scutellum, postscutellum, propodeum and base of abdomen of female from above; D, head of female; E, hind claw of female; F, head of male; G, antenna of male; H, male genitalia from above; I, penis in profile; J, right valva interna and externa from the inside.

Male.—Head somewhat flattened; seen in front, subcircular; seen from above, over three times as wide as long. Genae much narrower than in the female, about half as wide as the eye in profile. Ocelli much larger than in the female; posterior ocelli about one and one-third times as far apart as from the inner orbits, and about as far from the occipital margin as from the eyes. Eyes swollen, even more pubescent than in the female. Clypeus narrower, very slightly wider than long; its sides contiguous with the inner orbits over a long distance (about equal to the length of the third antennal segment). Antennae: scape shorter than in the female and almost straight, about two and one-half times as long as thick and slightly shorter than the three following segments together; second segment less than half the length of the third; third not quite twice as long as wide and less than one and one-half times the length of the fourth; fourth slightly longer than wide; fifth about as long as wide; sixth to twelfth wider than long; thirteenth slightly longer than wide, broadly rounded at apex; flagellum shaped about as in the female, but most of the segments bulging on the under side. Genitalia (Fig. 1H-J): stipites of valvae externae narrowed apically, the broadly truncate apex with blunt angles, the squamae long and slender, spiniform, extending much beyond the stipites; valvae internae divided into three lobes: the outermost lobe (or volsella) triangular, with blunt apex, shorter than the stipes against which it is appressed; the middle lobe (du Buysson's "tenette") large, hatchet-shaped, with two broad, blunt angles, one parallel with and about as long as the volsella, the other shorter and directed ventrad; the innermost lobe slender, finger-shaped, much shorter than the middle lobe; penis a broad rod, very obtusely rounded at the apex which is slightly curved upward; the basal convex shaft and the apical, flattened or slightly concave portion (the completely fused branches of the penis) about equally wide, but connected by a narrower neck which, on the under side, bears on each side a strong, slightly curved, blunt tooth, directed ventrad.

Length (h. + th. + t.1 + 2) of queen and worker, 7.5 to 9 mm.; of male, 7.5 to 8 mm.; length of fore wing of queen and worker, 8 mm.; of male, 7 mm.

Coloration.—*Queen and worker*.—Black. Head, thorax and legs with very few pale markings; a narrow yellow streak along the lower third of the inner orbits; middle of anterior margin of pronotum somewhat yellowish; a narrow, transverse, median yellow spot at the anterior margin of the post-scutellum. First abdominal tergite with a narrow, apical, pale yellow band; succeeding tergites and sternites with broad, pale

yellow, apical margins; sixth segment entirely yellow. Wings faintly smoky, with a strong yellowish tinge, especially marked in the anterior half of the fore wing; stigma and veins russet. Mandibles, under side of flagellum, terminal segment of tarsi, claws, and tibial spurs sometimes more or less ferruginous.

Male.—Yellow markings slightly more extensive: streaks along inner orbits reaching bottom of ocular sinus; interantennal area with two dots; anterior margin of clypeus broadly yellow; mandibles with small basal dot; under side of scape yellow; anterior margin of pronotum narrowly yellow almost to the humeri; yellow basal band of postscutellum extended to the sides. Under side of all coxae and trochanters yellow; fore and mid femora with a yellow streak on the under side. Under side of flagellum pale ferruginous throughout.

The foregoing description of the color pattern, based upon specimens from southeastern Texas, fits many of those from farther south, since variation in this species is rather limited. Frequently the yellow markings of the face and postscutellum disappear (in some, but not in all, wasps from Paraguay, Brazil, and Argentina). More rarely they may be more extensive. A few specimens have the extreme basal angles or (more rarely) the angles of the transverse ridge of the scutellum yellow.

R. du Buysson and Ducke recognize a var. *velutina* (Spinola) (= *aurulenta* Erichson), which is colored like the typical form, but is more densely covered with silky and somewhat golden pubescence. The distinction between this form and typical *lechequana* is very slight indeed and from a study of an extensive collection, covering most of the range of the species, I feel rather inclined to suppress the variety. At any rate, all specimens I have seen from Panama and farther north belong to typical *lechequana*.

N. lechequana var. *borellii* Zavattari is known from a single female, from Salta, Argentina. It is entirely black, except for a narrow, yellow, apical margin of the second tergite, almost interrupted in the middle. Perhaps this was merely an aberration.

Specimens Examined from the United States.—TEXAS: Brownsville, several workers and queens (C. Schaeffer) and two males (F. E. Lutz and H. F. Schwarz); Rio Hondo, two workers. ARIZONA: Nogales, one female (Oslar; paratype of *C. arizonaensis* Cameron, at Cornell Univ.).

In Texas *N. lechequana* occurs only in Cameron Co., where, in addition to the localities mentioned above, it was taken by Mrs. W. P. Cockerell at San Benito (Cockerell, 1927). Bradley's (1921) record from New Mexico appears to have been due to an oversight;

at any rate, I am unable to trace it either to a publication or to a specimen in a collection.

Distribution.—The range of the typical form covers most of Central and South America, from the southern border of Arizona to Buenos Aires. I have seen it from Mexico (Orizaba; Mitla; Yucatán), British Honduras, Guatemala, San Salvador, Costa Rica, Panamá (Ancon, C. Z.), Colombia, Venezuela, French Guiana, Brazil, Perú, Bolivia, Paraguay, and Argentina (Chaco de Santiago del Estero; Jujuy; Sierra de Córdoba). It is also known with certainty from Nicaragua, British Guiana, Ecuador, and Uruguay.

Ethology.—The following are, arranged chronologically, all published data referring to the nesting habits of *N. lecheguana*.⁹

Early accounts of honey-storing insects in tropical America undoubtedly refer in part to honey-wasps of the genus *Nectarina*, since these insects are often quite numerous and their nests more conspicuous than those of the native, stingless honey-bees (*Meliponidae*).¹⁰ Thus G. Pison (1648, *De Medicina Brasiliensi Libri IV*, p. 56) mentions the “bees” called “*eixy*” and “*copij*” in Brazil, which produce small quantities of excellent honey, yet neglected by the natives owing to the fierce sting of the insects. G. Maregravius de Liebstad (1648, *Historiae Rerum Naturalium Brasiliae Libri VIII*, p. 259) reports some observations on “bees” made by one Jacobus Rabbi, who lived many years among the Tapuya Indians of Brazil. Several of the insects mentioned are wasps, since they are said to build nests of paper and to sting “even so as European bees.”¹¹ In a later work, Pison (1658, *De Indiae*

⁹ This detailed digest of the literature is offered for a twofold purpose. It is, of course, important to focus attention upon the many gaps left in the history of the honey-wasps. On the other hand, I wish to emphasize that the habits of the Vespidae have not by any means been neglected to the extent some critics of modern Entomology would make us believe. It is customary for many latter-day “ecologists” to ignore the ethological data contained in taxonomic publications. Perhaps it is better so, since a narrow-minded contempt for taxonomic niceties renders these “biologists” singularly unfit for the task of properly correlating published observations on the habits of insects.

¹⁰ Latreille [1809, *Recueil d'Observations de Zoologie*, of Humboldt and Bonpland, I (1st Ed.) ; I have consulted the 2d Edition, pp. 268-276, published in 1812] gives a good résumé of the older accounts of American honey-storing insects.

¹¹ The insect called “*kitshaara*,” which hangs its nests in low trees, living “in alveolis dimidiam ulnam longis, instar chartae

Utriusque Re Naturali et Medica Libri XIV, pp. 111–113 and 287–288) repeats most of his former statements, but he adds a description and figure of an arboreal honey-storing wasp, recognized as such, evidently one of the color forms of *Polybia occidentalis*.¹²

Francisco Hernández (1651, *Rerum Medicarum Novae Hispaniae Thesaurus seu Plantarum Animalium Mineralium Mexicanorum Historia*; Lib. IX, p. 133) mentions several kinds of honey-storing bees and wasps of Mexico and even figures two of the nests. His figure labelled “*yzaxalasmilt*” is certainly the vesparium of *Nectarina lecheguana*, as recognized by H. de Saussure (1857–1858, *Et. Fam. Vesp.*, II, Introduction, p. cxxxiv), and is the earliest known figure of a nest referable without a doubt to this wasp.¹³

All of the preceding accounts are very vague and most of them are unsatisfactory for positive identification. The celebrated traveler, Felix de Azara (1809),¹⁴ however, gave much more definite information. He pointed out that the natives of Paraguay differentiated between honey-storing bees and wasps, the former being stingless and producing wax, the latter stinging and making no wax. Moreover, he clearly recognized two different species of honey-storing social wasps, known by the Guarani Indians as “*chiguana*” and

bibulae formati,” and storing excellent and very fragrant honey, may have been one of the forms of *Polybia occidentalis* (Olivier). The names “*kitshagk*” and “*heubig*,” applied to subterranean builders, may refer to *Polybia nigra* H. de Saussure (*P. atra* of de Saussure and most authors, but not *Vespa atra* Olivier), which usually nests underground and stores much honey. The honey called “*atshoy*” is also produced by a stinging wasp, living in arboreal, hard and black nests, possibly *Nectarina lecheguana*.

¹² “*Nidus minorum Vesparum (cujus iconem exhibeo) est plus quam majoris ovi oloris magnitudinis et formae, sed levissimi ponderis. Exterior obductus villosa, tenui et tenaci materia grisei coloris, qua avulsa apparent tres quatuorve tabulae parietibus distinctae, ex meris cellulis rotundis egregie fabricatae, et more parvi apiarii concinnatae. Quibus reconditum melligineum humorem haud facile quisquam impune attingit, quia Crabrones vix patiuntur se irritariet.*”

¹³ Hernández’ figure was copied by Latreille (1809, *Recueil d’Observations, etc.*, Humboldt and Bonpland, I, 1st Ed., Pl. XXI, fig. 4).

¹⁴ *Voyages dans l’Amérique Méridionale. Publiés d’après les Manuscrits de l’Auteur par C. A. Walckenaer. (Paris). 4 vols. and Atlas. The passage referring to honey-storing wasps is in vol. I, pp. 165–172 (“*chiguana*” and “*camuatý*,” pp. 171–172).*

"*camuatý*" respectively. The first name is even nowadays used in Paraguay and neighboring regions for *Nectarina lecheguana*, while the second is applied to *Polybia occidentalis* var. *scutellaris* (White). F. de Azara also called attention to the differences in the aspect and location of the nests of these two wasps; unfortunately, as recognized by Brèthes (1903, An. Mus. Nac. Buenos Aires, (3) I, p. 415), he transposed the native names, so that the nest which he credits to the "*camuatý*" is really that of *N. lecheguana*.

In his memoir on the South American bees, published in 1809 (1st Ed.) and 1812 (2d Ed.), Latreille refused to admit that any true wasps could store honey. He referred to the Meliponidae, or stingless bees, all previous accounts by Hernández, Pison, Marcgravius and de Azara of honey-storing insects in tropical America. A few years later (1824), however, he was forced to recant, when Auguste de Saint-Hilaire brought from southern Brazil specimens of the "*lechiguana*" wasp, together with some of the honey it stores¹⁵ and portions of the paper combs. A. de Saint-Hilaire [1822, Mém. Mus. Hist. Nat., Paris, IX, p. 373; and 1825, *Ibidem*, XII, pp. 296-306; see also his Voyage dans les Provinces de Rio de Janeiro et de Minas Geraes, (Paris), 1830.]¹⁶ narrates at length how he was poisoned by eating honey gathered from a nest of *N. lecheguana*. The nest was nearly oval, about the size of a man's head, built of a gray chartaceous material like the vesparia of Europe, hanging from the branches of a bush about a foot above the ground. The inhabitants of that part of South America are perfectly aware that the honey stored by this wasp may sometimes be poisonous, and they even claim to know the plant from which the poisonous honey is gathered.

Thomas Say (1837) concludes the description of his *Polistes mellifica* with the statement that "near Jalapa [Mexico], my attention was attracted by a group of Indians, who were eating honey from a paper nest, which was then so far dissected in their repast, that I could not ascertain its proper form. The honey had a pleasant taste, and so far as I could gather from their gestures, the nest was obtained from a tree."

¹⁵ Lassaigue (1824, Mém. Mus. Hist. Nat., Paris, XI, pp. 319-320) published an analysis of this honey.

¹⁶ Mr. Herbert F. Schwarz calls my attention to a footnote on p. 375 of vol. II of this work, in which de Saint-Hilaire doubts that the Brazilians would call *N. lecheguana* "abelha." However, this would be no stranger than the vernacular name "Mexican bee" given to this wasp in southeastern Texas.

Some of the accounts of exploration and travel in South America contain occasional references to honey-storing insects, but in most cases it is impossible to refer them to either bees or wasps. R. Schomburgk's (1848, *Reisen in Britisch Guiana*, II, p. 104) description of a paper nest made by a stinging "bee" in a tree, looking much like that of *Vespa* and containing very sweet honey, probably refers to *N. lecheguana* var. *velutina* (Spinola). That wasp was described by Erichson, as *Brachygastera aurulenta* (1848, *Ibid.*, III, p. 590), from specimens collected by Schomburgk during his journey.

To H. de Saussure (1853-1858, *Et. Fam. Vesp.*, II) we owe the first adequate descriptions and figures of the nests of *Nectarina*. His Pl. XXX reproduces a photograph of a nest of unknown origin, which he refers to *N. lecheguana* in the Explanation of the Plate, although in the Introduction (p. cxxxiv) he says that he does not know for certain which species built the nest. This figure shows quite well how a new comb is started by the wasps building cells on to the outer cover or envelope of the nest; the new cells at first form irregular, unconnected patches, each patch, when completed, being covered with its own paper envelope; eventually all the patches fuse and the one resulting comb is enclosed by one single, continuous envelope. The whole nest is nearly spherical, a little over one foot in diameter, fixed to a branch running through the whole nest. H. de Saussure's detailed description of the inner structure is based upon nests which he studied in Mexico, a cross-section of one of them being shown in his Pl. XXX *bis*.¹⁷ Outside, the nests resemble those of *Vespula*, being likewise irregularly sub-spherical and built of similar gray paper, but thinner; the outer envelope, however, is a single, rather irregular sheet of paper (in *Vespula* it consists of several concentric sheets or of many imbricated scales). The single or double entrance at the lower end is rather wide and slit-like. On a cross-section, the nest is seen attached to branches about which it forms a number of strongly con-

¹⁷ In the Explanation of this Plate the nest is referred to *N. mellifica*, although according to the Text of vol. II (p. 233) H. de Saussure had not recognized this species. The seeming contradiction is explained by the fact that the taxonomic part (pp. 1-256) and most of the Plates of the second volume of de Saussure's 'Etudes' were published in 1853-1855, while the Introduction (pp. i-cc) and some of the plates were issued in 1857-1858, after the author's return from Mexico. R. du Buysson says that the nests figured by de Saussure are yet extant at the Paris Museum.

vex and more or less concentric combs, the size of the combs and the number of cells increasing from the first or innermost to the last or peripheral comb. At the same time the successive combs become less convex, the inner ones being more nearly spherical, the outer ones more cap-shaped. To pass from one tier to another the wasps use one or more spiral ramps or corridors: each comb is pierced with one or more holes and connected at each hole with the combs above and below it by means of plates (covered with cells on the under side), the successive plates being arranged so as to form a spiral ramp. H. de Saussure found as many as five of these ramps in a single nest, but most of them ran only through some of the combs; only two of them ran throughout the structure, ending below in an entrance to the nest. The ramps not only help the movements of the wasps within the nest, but add to the strength of the structure, which is, moreover, well supported by the many branches that cross it in every direction. The peculiar manner in which the nest grows, by addition of a new comb in patches on to the outside cover, has been described above. As de Saussure justly points out, the nests of *Nectarina* are among the most remarkable built by any wasps (or any insects, for that matter). They manage to contain the largest number of cells within the smallest space, providing at the same time for a maximum of solidity and comfort and a minimum of labor and material. Although they are not the largest structures built by wasps, since they do not exceed two feet in diameter, they are certainly the most populous.

K. Möbius' (1856; as *Chartergus sericeus*) descriptions and figures of two nests from Puerto Cabello, Venezuela, agree in the main with those given by de Saussure. Both nests were subglobular, the larger being 50 cm. across and containing approximately 60,000 cells, each cell 6 to 7 mm. deep and 4 to 5 mm. wide. The combs were placed about 10 mm. apart. There were several entrances to the nests. While the outer envelope was of fibrous plant material, the walls of the cells were built mostly of hair cells. Möbius found that the full-grown larva spins over the top of the cell a grayish white, convex cap, 4 to 5 mm. high.

F. Smith (1863) discusses the true significance of honey-storing habits in some South American wasps. He writes: "When a wasp's nest is discovered, in which the combs are constructed of a material adapted for containing honey,¹⁸ and in which young brood

¹⁸ In preceding paragraphs of the same paper Smith argues that papery or carton cells are not suitable as honey containers, like the waxen cells of the social Apoidea.

is also found, showing this habit to form a part of the usual economy of the species, then we shall have some legitimate grounds for believing in the existence of certain species of wasps being, in the true signification of the term, honey collectors. At present, it appears to me, that we only know as a fact, that certain wasp-nests occasionally contain honey, supposed to have been stored by the wasps themselves; they, in the first place, not having constructed their cells of a material adopted for containing it. The nests of *Nectarina analis*, and also of *N. lecheguana*, are all constructed of papyraceous materials, but of a somewhat firmer texture than those of *Polybia*. All the species of *Nectarina* are said to be honey collectors; if such be the case, may it not be possible that it is stored up at a period when the rearing of brood is suspended, and when they are prevented from collecting food abroad, the honey forming their support during such a season; or is it simply to be regarded as booty obtained by the plunder of nests of honey-collecting bees, and that deserted wasps' nests are merely used as temporary receptacles." This passage calls for the following remarks. There is absolutely no reason to doubt that *N. lecheguana* collects directly from flowers the honey it stores in the nest, and this wasp has never been observed robbing bees' nests. Moreover, the paper combs of *Nectarina* form excellent containers for honey under natural conditions, even though the cells filled with honey are never capped over. Smith was deceived by the appearance of nests that had undergone the many hazards of a long journey to Europe. It must, however, be recognized that we do not yet know, from direct observation, what use the wasps make of the stored honey, whether it is ever fed to the brood or serves only as sustenance to the adults during times of distress.

In a suggestive paper "On the Construction of Hexagonal Cells by Bees and Wasps," F. Smith (1864) defends the theory that the hexagonal structure of the combs is due not merely to the reciprocal adjustment of cells arising from consecutively constructed hemispherical bases, but that wasps and bees commence the combs "with the intent instinctively to build hexagonal cells." In support of this view he calls attention to a nest of *N. lecheguana*. "The nest of this wasp," he says, "is of globular shape, and is sometimes not less than 16 or 18 inches in diameter; the foundation is a single comb, enclosed in a globular envelope; *on this envelope* the wasps commence series of cells *on all sides*; these cells are covered in patches by envelopes, the envelope always serving as the foundation of a fresh series of cells: a repetition of the above proc-

ess, on all sides of the continually increasing nest, results in structures such as I have described. Now you will observe, that all the cells constructed by these wasps are built upon the flat outer envelopes, and if you examine the specimens exhibited, you will see, in some instances, the faintest ground-plan of the hexagonal cell intended to be raised, traced on the flat foundation." Smith might have added, as further proof that these wasps intentionally build hexagonal cells, that, when the several patches of cells, started at various spots of the outer envelope, eventually come together, much skillful readjustment of cells is called for in order to produce a single comb of perfectly hexagonal cells. Social wasps seem therefore to be endowed with a certain amount of geometrical sense, as well as with the ability for concerted teamwork. Their activities can hardly be explained wholly in terms of rigid, stereotyped instinctive behavior or reflexes, even though their solitary ancestors may have started with a simpler, more fortuitous architecture.

According to H. von Ihering (1896), the colonies of *Nectarina* are perennial and are started by swarms from some older colony. He noted that the vesparia of *N. lecheguana* (as *N. mellifica*), in southern Brazil, are usually placed rather low and are very rich in honey. They often are preyed upon by the lizard, *Tupinambis teguixin* (Linnaeus). He observed one of the nests that, in the fall, contained about as many males as workers. The latter contained for the most part eggs; but, owing to the rudimentary receptaculum seminis (or spermatheca) he regarded them as workers. He suspects that in this wasp also the eggs laid by workers produce males, which would explain the exceptionally large number of males. His son, Rud. von Ihering (1904), described a nest, from the State of São Paulo, consisting of about 20 combs and measuring 27 by 39 cm.; it had several entrances.

R. du Buysson (1905) records many interesting observations made by L. Digue, in Mexico, and E. R. Wagner, in Argentina. The vesparia of *N. lecheguana* are perennial, lasting for several years, and each contain several fertile, ovipositing females. Digue brought from Mexico the major part of a colony, preserved in alcohol, of which one-sixth about were large queens with free eggs in the oviducts, ready to be laid. In the spring one finds very small nests, evidently started by swarms of several fertile queens and a few workers. The egg is placed in or near the bottom of the cell. R. du Buysson also gives a detailed description and a figure of the full-grown larva, which is so large that it protrudes for about one-third of the length beyond the rim of the cell. In

Mexico the honey of these wasps is highly prized by the Indians, who do not regard the insects as very aggressive. In Jalisco the honey is gathered every year in December, the wasps being readily chased from the nest by smoke; the nest is then broken off, the basal comb being left on the bush, because, it is said, the old colony then promptly rebuilds on the same spot. Wasp honey is often sold in the market. It is very limpid and strongly scented, but crystallizes more rapidly than bees' honey. Sometimes, when the *Daturas* are in bloom, the honey may be toxic, and cases of poisoning are not rare. Some of the Indians also raise the nests, cutting them when they are small and carrying them, tied in cloth, to their gardens. R. du Buysson's Plates XV and XVI are photographs made in Oaxaca from a nest that had been kept in a garden for a year only, where it had grown from a sphere 10 cm. across to a more irregular vesparium, 34 cm. by 29 cm.¹⁹ In northern Mexico and in northern Argentina, *N. lecheguana* withstands rather low temperatures and even slight frosts (-5° C.); the adults then hibernate hidden in the cells, from which only the tip of the abdomen protrudes. R. du Buysson assumes that the larvae are fed honey and balls made by the workers chewing up tender insect larvae. Yet he states that, after examining several nests, he never found in them chitinous insect remains or mutilated prey, such as are easily seen in the closed vesparia of *Vespa* and *Polybia*. As I have pointed out before, the actual food and manner of feeding of the larvae have not yet been observed in nature.²⁰

The few observations made on *N. lecheguana* near Brownsville, Texas, may conveniently be grouped together. H. S. Barber (1905), who seems to have observed them first in that region, exhibited a photograph of a nest at a meeting of the Entomological Society of Washington. The nest, he stated, was similar to that of *Vespa maculata*, except that in its lower portion the cells were exposed. It was globular in shape and about 9 inches in diameter. The wasp was said to produce a palatable honey. F. C. Pellett (1922) reports some observations made by beekeepers of the Lower Rio Grande Valley, who stated that the wasps stored honey and swarmed like bees. "When they sting they lose their stings as do

¹⁹ These photographs are reproduced by H. F. Schwarz (1929).

²⁰ In this connection it may be mentioned that the adults of many social wasps of South America steal meat or dead fish exposed to the sun. This habit is recorded for *Nectarina augusti* by Bertoni (1911, An. Mus. Nac. Buenos Aires, (3) XV, p. 114), so that *N. lecheguana* might be expected to do likewise.

the honeybees." A nest, shipped to Hamilton, Illinois, was kept with a living colony throughout the summer; but the wasps all died the following winter. Herbert F. Schwarz (1928 and 1929) published a most interesting study of the habits of this wasp, locally known as the "Mexican bee," because of the partiality of the Mexicans for the honey it produces. He noted that the insect is rather unaggressive, even when a colony is disturbed, although it is quite able to sting and then leaves the sting in the wound. The after-effects of the sting may be quite severe. One of the two nests found in January contained neither larvae nor honey, though there was a strong smell of honey in the combs; some 15,000 wasps were collected from that nest, one in every fifteen being a male. Some days later a number of the wasps were caught visiting flowers, so that even in the region of Brownsville they are not completely dormant throughout the winter. The two photographs, reproduced on Plates XXVII and XXVIII, represent a nest taken by Mr. Herbert F. Schwartz and Dr. F. E. Lutz at Brownsville and now preserved at the American Museum of Natural History.

Sources of Honey.—Although the species of *Nectarina* are very active gatherers of honey, their mouth-parts show apparently no departure from those of most other social and solitary Vespidae that only casually imbibe flower secretions. The tongue and maxillae are very short and broad and differ only in minor details from those of *Vespa*.²¹ One might therefore expect that *N. lecheguana* will gather nectar on many different kinds of flowers and will show no decided preference for any particular floral type. Owing to its small size, it is able to tap not only flowers with freely or shallowly exposed nectar, but even some where the nectar is deeply hidden. The rather scanty published data and my own observations in Yucatán and Guatemala fully support these conclusions. Dueke (1904, Bol. Mus. Goeldi, Pará, IV, p. 319) lists some of the plants that are visited by social wasps near Pará, Brazil, but does not state which of them were observed being visited by *Nectarina* (as R. du Buysson claims). According to R. du Buysson (1905), L. Diguët saw *N. lecheguana*, in Mexico, preferably at flowers of peach-trees, mango-trees and large Compositae. Mrs. W. P. Cockerell collected this wasp at San Benito, Texas, visiting flowers of

²¹ Compare, for instance, du Buysson's figures of the mouth-parts of *N. lecheguana* (1905, Ann. Soc. Ent. France, LXXIV, Pl. XII, figs. 1-3) with those of *Vespula vulgaris* (1903, Loc. cit., LXXII, Pl. III, figs. 1-4). In both *Vespula* and *Nectarina*, the maxilla bears on the inner side a well-developed comb of stiff setae.

Koeberlinia spinosa Zuccarini (Cockerell, 1927). Schrottky (1908), in Paraguay, lists it among the visitors of two introduced plants, *Delphinium Ajacis* Linné and *Oxalis* sp.

In Yucatán (region of Chichen Itzá, May to July, 1929) I observed *N. lecheguana* at the flowers of *Acacia Collinsii* Safford, *A. Gaumeri* Blake, *A. riparioides* (Britton and Rose), *Melampodium divaricatum* (L. Richard), *Eupatorium albicaule* Schultz Bip., *Calliandra acuminata* Humboldt, Bonpland and Kunth, *Ehretia tinifolia* Linné, *Boerhaavia erecta* Linné, *Croton fragilis* Humboldt, Bonpland and Kunth, and *Achyranthes aspera* Linné. In Guatemala (in the coffee-growing district at Mocá near Guatalón and near Pochuta, February to May, 1931) it was taken at *Acacia Hindsii* Benthams, *Baccharis trinervis* Persoon, *Borreria suaveolens* Meyer, *Sclerocarpus divaricatus* (Benthams), *Euphorbia heterophylla* Linné, *Melampodium divaricatum* (L. Richard), and *Eupatorium morifolium* Miller; and it was one of the most common visitors of the flowers of the mango-tree (*Mangifera indica*).

T. Belt (1874, *The Naturalist in Nicaragua*, p. 228) noted, in Nicaragua, that the wasps of the genus *Nectarina* visit frog-hoppers for the sake of the sweet exudations of these insects.

N. lecheguana is often seen sucking moisture on wet sand or at the edge of water (Schrottky, 1909, and personal observations in Yucatán and Guatemala). According to E. R. Wagner (in R. du Buysson, 1905), after drinking the wasp rises a little and then flies in a direct, horizontal line toward the nest on to which it suddenly drops. The natives of northern Argentina are aware of this behavior and they follow the flight-line of the wasps on horse-back, in order to find the nest.

Homeomorphy and Homeochromy with Other Insects.—In Central and South America, *Nectarina lecheguana* is one of the most abundant members of a group of insects (mainly Hymenoptera) which, through parallel variation combined with regional convergence, have assumed a most deceptive resemblance in general shape and color pattern. This group of so-called "mimics" includes the following genera and species, at present known to me; but no doubt the list could be considerably extended.²²

²² In order to escape the theoretical implications unavoidably connected with the terms "*mimic*" and "*mimicry*," I intend to use in the future the neutral terms *homeomorphic*, *homeomorphy*, *homeochromic* and *homeochromy*, for superficial resemblances in shape or color among different species of arthropods. These terms group the facts without alluding to their possible interpretation or origin.

Hymenoptera. Eumeninae: *Pachodynerus nasidens* (Latreille); *P. brevithorax* (H. de Saussure); *P. argentinus* (H. de Saussure); *Odynerus similis* Smith; *O. peyroti* H. de Saussure; *O. otomitus* H. de Saussure; *O. cordovae* H. de Saussure; *Ancistrocerus parredes* (H. de Saussure); *A. arista* (H. de Saussure). Sphegoidea: *Gorytes similicolor* R. Dow (of Paraguay); *Cerceris maximiliani* de Saussure (of British Honduras and Yucatán; det. R. Dow). Apoidea: *Megachile aurantipennis* Cockerell; *M. microsoma* Cockerell; *M. pulchriventris* Cockerell; *Anthidiellum auricolle* (Friese); *A. apicale* (Cresson); *Hypanthidium taboganum* Cockerell; *Dianthidium nectarinioides* Schrottky; *D. manni* Cockerell; *D. holmbergi* Cockerell;²³ *Epeolus fulvopilosus* Cameron (which plaits the fore wings longitudinally at rest); *E. xanthurus* Cockerell; *E. cameroni* Meade-Waldo; *Trigona postica* (Latreille);²⁴ *Stelis costaricensis* Friese; *Halictus sericeus* Friese. Chalcidoidea: an undetermined species of Chalcidinae, which I have taken in Guatemala.—Diptera. Stratiomyidae: *Stratiomys mutabilis* (Fabricius).

Of the insects listed above, *Pachodynerus nasidens* (Syn.: *Odynerus cariniscutis* Cameron) is the only species found thus far in southern Arizona and Texas together with *N. lecheguana*.²⁵

²³ In describing these and some other related Anthidiinae, Cockerell (1927, Proc. U. S. Nat. Mus. LXXI, Art. 12, p. 2) writes: "The whole series of Bolivian *Dianthidium* now before me may apparently be referred to *Anthodiocetes*, which may be regarded as a subgenus. These bees, with certain species of *Psaenythia* (as *P. collaris* Schrottky and *P. facialis* Gerstaecker) and the wasps of the genus *Nectarinia* appear to constitute a case of Müllerian mimicry." Cockerell also describes *Anthidium beniense*, in which, he says, "the wings fold longitudinally after the manner of *Nectarinia*." Of the several Anthidiine bees recorded by Cockerell, only *D. manni* and *D. holmbergi* appear to be homeochromic with *N. lecheguana*; the remainder seem to resemble rather other species of *Nectarinia*.

²⁴ A worker of *T. postica* was kindly sent to me by Mr. Herbert F. Schwarz. It offers in my opinion as good a superficial resemblance to *N. lecheguana* as any of the other bees of my list, although Mr. Schwarz did not regard the resemblance as striking. Moreover, Mr. Schwarz added in his letter: "With this specimen I am enclosing a few other closely related insects (of the genus *Trigona*) which depart still further from the appearance of *Nectarina* and suggest that such resemblance as *postica* bears to *Nectarina* is probably merely a chance resemblance."

²⁵ I have seen *P. nasidens* from Palmerlee, Ariz.; Dragoon, Cochise Co., Ariz.; and Brownsville, Texas.

The *N. lecheguana* color group is only one of many homeo-chromic groups of South American insects. Most of these groups center about one or more species of social Vespidae, and include, together with a few insects protected by stings, others that are apparently defenceless. Each group then is a mixture of insects with "warning colors" (Poulton's synaposematic mimicry) and others with "deceitful colors" (Poulton's pseudaposematic mimicry). Whether or not these groups are examples of true mimicry, effectively protecting, at least to some extent, their members against potential enemies, is open to question. It is even more debatable whether these several groups, comprising together many hundreds of species of insects, could have been produced by the mere chance working of Natural Selection upon the ordinary fluctuating variations of their ancestors. In a discussion of the two distinct problems of the actual meaning and the possible origin of deceptive resemblance, many points should be carefully considered, some of which are overlooked or underrated by the mimicry enthusiasts. It is, for instance, rather baffling that in the case of the color group centering about *N. lecheguana*, some of the members cover a very wide territory, being found alone in certain areas. This is notably the case for *Pachodynerus nasidens*, an extremely "pushing" wasp that thrives perfectly and even invades new territory in the absence of any of its so-called "mimics," which are supposed to help it by "warning" its enemies. *P. nasidens* is the only member of this color group known from the Antilles and in recent years it has become extremely abundant in the Hawaiian Islands, having been accidentally introduced there by man. Its rapid invasion of the Hawaiian Islands is the more remarkable, since that Archipelago has its own peculiar groups of Eumeninae (of totally different color patterns). According to the theory, *P. nasidens* would be particularly handicapped there in attempting to escape the predacious enemies that had not "learned" to recognize its pattern. If *P. nasidens* needs no "synaposematic" protection in Hawaii, why should it and other similarly colored wasps be helped by such protection in America?

Enemies and Parasites.—Among the arthropod enemies of *N. lecheguana* may be mentioned certain asilids. At Chichen Itzá, Yucatán, I caught a female *Promachina trapezoidalis* (Rondani) (named by S. W. Bromley) devouring a worker of this wasp. I have quoted above H. von Ihering's observation of the lizard, *Tupinambis teguixin* (Linnaeus), feeding upon these wasps in southern Brazil. Probably some birds also attack them or their nests. We

are, however, woefully ignorant of the feeding habits of Neotropical birds. Prince Maximilian of Wied (1830, Beiträge zur Naturgeschichte von Brasilien, III, Abt. 1, p. 159) states that the red-throated caracara, *Ibycter americanus* Boddaert (*Falco nudicollis* Daudin), of the forests of southern Brazil, lives to a large extent on bees and wasps of unknown species ("Marimbondos"), of which it even attacks the nests. He found several times the stomach of this bird filled with wasps.

Salt and Bequaert (1929) saw a female of *N. lecheguana*, from Tacna, Rio Putumayo, Perú, bearing a female Strepsipteron under the fifth tergite. No other parasites are at present known.

Mischocyttarus H. de Saussure

Mischocyttarus H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 19 (for two species: *Zethus labiatus* Fabricius, 1804, and *Mischocyttarus smithii* H. de Saussure, 1853-1855; type by designation of Ashmead, 1902, Canad. Entom., XXXIV, p. 166: *Zethus labiatus* Fabricius, 1804).

Mischocyttarus H. de Saussure, 1852, Et. Fam. Vesp., I, Introd., p. viii, footnote, without description or species; *nomen nudum*).

Polybia subg. *Polybia* div. *Kappa* H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 200 (for eight species; *Polybia injucunda* H. de Saussure, 1853-1855, the first species, is herewith designated as the type).

Polybia subg. *Polybia* div. *Omega* H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 206 (monotypic for *Polybia filiformis* H. de Saussure, 1853-1855).

Megacanthopus Ducke, 1904, Bol. Mus. Paraense, IV, pp. 320 and 358 (for nine species; *Megacanthopus collaris* Ducke, 1904, the second species, is herewith designated as the type).

Monacanthocnemis Ducke, 1905, Rev. d'Ent., Caen, XXIV, p. 21 (monotypic for *Polybia filiformis* H. de Saussure, 1853-1855).

Pseudopolybia H. v. Ihering, 1896, Zoolog. Anz., XIX, p. 452 (by inference for *Polybia vicina* H. de Saussure, 1853-1855, and *Polistes ignobilis* Haliday, 1836; type by present designation: *Polistes ignobilis* Haliday, 1836 = *Vespa atra* Olivier, 1791). Not *Pseudopolybia* H. de Saussure, 1863.

Generic Characters.—Body elongate, slender. Head broad and short; eyes bare; ocelli normal; oculo-malar space well-developed but short, sometimes very short; genae broad, not separated by a carina from the postgenae; vertex also rounded off into the occiput; clypeus short, its lower portion broadly triangular and bluntly rounded off or more or less pointed at

apex; mandibles moderately broad, the apical or cutting edge slightly oblique and with three subequal lower teeth, the fourth, upper tooth smaller; maxillary palpi 6-jointed; labial palpi 4-jointed, the apical segment without erect inner seta. Antennae of 12 segments in female and worker; of 13 segments in male, the flagellum being either of normal shape or with some of the segments modified in various ways and then often curled up. Thorax usually elongate and slender, always longer than wide or thick; anterior margin of pronotum truncate, dorsally with or without rim, the humeri angular or rounded off; mesonotum without notauli; scutellum large, rectangular, cushion-shaped, uniformly but slightly convex; postscutellum (true metanotum) transverse, slightly convex, separated from the propodeum by a deep, straight suture; propodeum more or less elongate, with flattened sides, its median portion oblique and more or less concave, without even a trace of median basal area; scutellum, postscutellum and propodeum forming a continuous slope; valvae surrounding the retractor muscle low, forming a broadly oval or elliptical dorsal orifice; mesopleura divided by a distinct mesepisternal suture into an upper and a lower plate, without epicnemial suture; mesepimeral suture well developed. Abdomen as a rule long and slender, the posterior segments little or hardly retractile within the second; first tergite long, much narrower than the second, always stalk-like and sometimes with a narrower basal portion. Legs long; coxae larger than usual; third and fourth segments of mid and hind tarsi asymmetrical, the inner apical lobe produced and decidedly longer than the outer lobe (the difference as a rule more pronounced on the fourth segment); claws of mid and hind legs more or less asymmetrical, often strongly so; mid tibiae with two apical spurs (except in the subgenus *Monacanthocnemis*). Wing venation of the usual vespid type; fore wing with the basal vein ending a short distance from the stigma; radial cell long, but only slightly narrowed apically; hind wing with a long and narrow basal (or posterior) lobe, the preaxillary excision rudimentary or absent. The males differ from the queens and workers mainly in the flattened face and the shape of the clypeus which is more truncate anteriorly. Queens and workers are structurally alike and are difficult to distinguish even by size.

Taxonomy.—As defined above, *Mischocyttarus* includes, not only the few larger species related to the genotype, but also the more numerous smaller forms which Ducke at one time separated under *Megacanthopus*. The latter he originally (1904, p. 358) defined as follows: "Ocelli et clypeus normales. Marium antennae (an in

speciebus omnibus?) ad apicem involutae, articulo ultimo acuminato vel compresso-dilatato. Scutellum plus minusve convexum, post-scutellum et segmentum medianum plus minusve obliqua. Abdomen longe petiolatum, petiolo apicem versus nunquam repentine incrassato, sed plus minusve gradualiter dilatato. Pedes intermedii et postici tarsorum articulis 3° et praecipue 4° lobo interno in spinam longissimam producto." None of these characters are really diagnostic, since they are present in the genotype of *Mischocyttarus* as well. Ducke, however, in the key to the genera proposed the following distinction (1904, p. 320):

Corpus compressum, valde elongatum. Abdominis segmentum 1^{um} thorace haud brevius. Ocelli in triangulo distincte altiore quam lato. Longitudo corporis 18 mm. haud inferior:

Mischocyttarus.

Abdomen depressum, plus minusve ovale; si petiolus thoraci longitudine aequalis vel superior est, corporis longitudo est 18 mm. multo inferior. Ocelli in triangulo aequilato vel altitudine latiore: *Megacanthopus*.

These characters, again, do not allow of any clear-cut distinction. Among the species placed by Ducke in *Megacanthopus* one finds every passage from compressed to depressed bodies, as well as from long to short petioles. *M. flavitarsis* is about as large as *M. labiatus* and one finds every gradation in size, evidently regardless of relationship. The shape of the ocellar triangle, likewise, is unreliable; for instance, I am unable to discover any appreciable difference in this respect between *M. labiatus* and *M. flavitarsis* or *M. carbonarius* (de Saussure).

Monacanthocnemis was separated by Ducke (1905) from *Megacanthopus* and *Mischocyttarus*, owing to the presence of one spur only at the apex of the mid tibia. Originally it was monotypic; but later (1906, Rev. d'Ent., Caen, XXV, p. 9), Ducke also referred to it his *M. buyssoni*. Apart from the character of the tibial spur (which is exceptional in social wasps), both *M. filiformis* and *M. buyssoni* are typical *Mischocyttarus*. In this case, as in that of *Zethus*, the number of tibial spurs seems to vary regardless of true relationship.

In his more recent papers, Ducke recognized that *Megacanthopus* and *Monacanthocnemis* could at the most claim subgeneric rank (1914, Zool. Jahrb., Abt. Syst., XXXVI, p. 317), and in his recent Catalogue of the Social Wasps of Brazil (1918, Rev. Mus. Paulista, X, pp. 368-369) he points out that these two groups exhibit no ethological differences from *Mischocyttarus*.

Mischocyttarus thus becomes a very extensive genus and it is at present difficult to get a correct idea of the number of species it contains. Ducke (1918) recognizes 22 valid species from Brazil alone, and one more has been described since. To these should be added at least 6 from North and Central America and the West Indies. There are probably in all some 30 to 35 valid species known.

In order to indicate the relationships of the two species found in the United States, I have added all the West Indian forms to the subjoined key.

KEY TO NEARCTIC AND WEST INDIAN SPECIES

1. Large species: fore wing 12 to 18 mm. long. Oculo-malar space short; in female and worker about the length of the eighth antennal segment. Head swollen; genae about as wide as the eye in profile. Anterior margin of pronotum very slightly raised; its humeral angles rounded, not projecting. Claws of mid and hind legs about equally thick in each pair, but one of them slightly longer. First abdominal segment long but rather thick, about one and one-third times as long as the second tergite. Male: antennae curled up, all the segments of the flagellum much longer than wide, the last one very slender; clypeus subrectangular, its lateral margins broadly separated from the eyes. Species of Western North America. *M. flavitarsis* (H. de Saussure).
- Much smaller species: fore wing 7.5 to 11 mm. long. Male (as far as known): antennae normal, most of the segments of the flagellum as wide as or wider than long (except the basal 2 or 3), the last short and conical; clypeus transversely pentagonal, its lateral margins touching the eyes over a long distance. 2.
2. Claws of mid and hind legs strongly asymmetrical, one of the claws in each pair being much longer and thicker than the other. Head of normal shape; genae narrower than the eye. Oculo-malar space very short; in female and worker much less than the length of the eighth antennal segment. Anterior margin of pronotum much raised, with distinctly projecting, obtuse humeral angles. First abdominal segment long and slender, at least one and one-third times as long as the second tergite. Southeastern United States, Cuba, Jamaica, Mexico, Central America *M. cubensis* (H. de Saussure).
- Claws of mid and hind legs almost equally thick in each pair, but one of them slightly longer 3.

3. Oculo-malar space very short; in female and worker much less than the length of the eighth antennal segment. Head moderately swollen; genae narrower than the eye. Anterior margin of pronotum distinctly raised; humeral angles slightly projecting. First abdominal segment long and slender, one and one-third times as long as the second tergite. Santo Domingo, Porto Rico, Virgin Islands.

M. phthisicus (Fabricius).

Oculo-malar space long; in female and worker over the length of the eighth antennal segment. Head much swollen; genae almost wider than the eye. Anterior margin of pronotum very slightly raised, its humeral angles rounded, not projecting. First abdominal segment much shorter and more stubby, little over the length of the second tergite. Male unknown. Cuba. *M. bruneri* Bequaert and Salt.

The two Nearectic species of *Mischocyttarus* are only remotely related. *M. flavitarsis* belongs to the section of the genus most numerous in species, in which the antennae of the male are very slender, with much lengthened segments and with the tip of the flagellum curled up. It is, however, not very closely allied to any of the Neotropical species known to me and could not possibly be confused with any of them. I am inclined to believe that this wasp was originally a member of the true "Californian fauna," which, according to E. C. Van Dyke, "has either been evolved within its own territory or more likely has worked north in early geological times from the lands to the south or Lower California" (1929, Trans. 4th Internat. Congr. Entom., Ithaca, Aug. 1928, II, p. 565). Like many other elements of this fauna, *M. flavitarsis* later worked its way into and even beyond Sonoran territory.

The nearest relatives of *M. cubensis* are *M. bruneri* and *M. phthisicus* in the Antilles; and *M. alfkenii* (Ducke) and *M. basimacula* (Cameron) in Central and South America.²⁶ In all these species, so far as known, the antennae of the male are simple, dif-

²⁶ *M. alfkenii* is the South American species called "*M. indeterminabilis*" by Ducke, R. du Buysson, and Bertoni. *Polybia indeterminabilis* de Saussure (1853-1855, Et. Fam. Vesp., II, p. 201; no sex) was described from "Amérique du Sud. Ile Sainte-Lucie," and has not been properly recognized. Since St. Lucia is the only definite locality mentioned, it should be taken as the type locality. I have, unfortunately, never seen a Polybiine wasp from that island and I am therefore unable to throw light upon *P. indeterminabilis*. The meagre description could apply as well to *P. phthisicus* of the Antilles as to at least three species from Trinidad and the north

fering little from those of the queen and worker: the flagellum is straight and composed of short, broad segments. My key shows the slight, but apparently reliable, structures separating *M. cubensis*, *M. bruneri* and *M. phthisicus*. *M. alfkenii*, which I have seen from eastern Perú and Paraguay, is very closely related to *M. cubensis*, agreeing with it in all the structural characters mentioned in my key. I am unable to find differences in the queens and workers; but in the male of *M. alfkenii* the clypeus appears to be more rectangular and its apex blunter and less projecting than in *M. cubensis*, while the terminal (13th) antennal segment appears to be more stubby. Quite possibly *M. alfkenii* is not really separable from *M. cubensis* var. *mexicanus*, with which it agrees in color. On the other hand, *M. basimacula* is, in my opinion, structurally distinct. It has the asymmetrical claws, the narrow genae, the very short oculo-malar space and the raised pronotal margin of *M. cubensis* and *M. alfkenii*; but it differs from both these species in the much shorter first abdominal segment, which in profile is hardly longer than the second tergite; seen from above, the first tergite is three times as wide at apex as at base, the basal stalk being about one-third the length of the tergite; while, in the male, the clypeus is hardly wider than long (in *M. cubensis* and *M. alfkenii* markedly so). *M. cubensis* may be regarded as a Neotropical element in the autochthonous Greater Antillean fauna, which at a comparatively recent period (probably after the last Glacial Epoch) invaded Florida and gradually spread northward, where it now reaches as far as climatic conditions will allow it.

Distribution.—Like *Nectarina*, the genus *Mischocyttarus* is one of several groups of social wasps that give the Neotropical Region its distinctiveness. Owing to the presence of one species in western North America, it extends from Vancouver to Buenos Aires in northern Argentina. In eastern North America it reaches north-

coast of South America. *M. alfkenii* has also been distributed under the name "*M. bistriatus* F."

M. basimacula (Cameron) (= *Polybia basimacula* Cameron, 1906, Invertebrata Pacifica, I, p. 150; ♀), originally described from Belize, I regard as a valid species, structurally different from *M. alfkenii*. It is very common in Central America, where I have seen it from Guatemala, the Republic of Honduras, Costa Rica and Panamá. Records from South America proper, however, appear to be all erroneous and to refer to *M. alfkenii*, which sometimes is colored exactly like *basimacula*. It would seem that Ducke and R. du Buysson confused *basimacula* with *M. cubensis* var. *mexicanus*, which perhaps is not distinct from *M. alfkenii*.

ward to southern Georgia. It also covers the Antilles, but is absent from Chile. The center of density (if not of dispersal) nowadays is Brazil and the Guianas, with 28 species. To the north and the south of that area the species rapidly fall off in numbers (4 species reach northern Argentina; 6, Mexico; 3, the Antilles; 2, the United States).

Most of the species have a rather limited distribution, but this may be partly due to insufficient knowledge. A few, however, cover a very extensive area. Thus *M. ater* (Olivier) (Syn.: *Polybia socialis* H. de Saussure; *Polistes ignobilis* Haliday; *Polybia decepta* Fox; and *Megacanthopus imitator* Ducke) is known from Mexico to Misiones; *M. labiatus* (Fabricius) (Syn.: *Polybia melanaria* Cameron; *Megacanthopus violaceipennis* Cameron; and *Megacanthopus longipetiolatus* Cameron) extends from Tepic, in Mexico, to Uruguay; and *M. drewseni* H. de Saussure (Syn.: *Megacanthopus atriceps* Cameron; and *Megacanthopus rotundicollis* Cameron) from Colombia to Buenos Aires. None of these widely distributed species enter the United States.

Ethology.—The nests are known for at least 18 species of *Mischocyttarus*. I have personally studied those of *M. flavitarsis*, *M. cubensis*, *M. basimacula*, *M. collaris* (Ducke), *M. metathoracicus* (H. de Saussure), and *M. cassununga* (R. von Ihering). The nest is always of the same "gymnodomous and stelocyttarous" type (H. de Saussure) as that of *Polistes*, consisting of a single, free comb of hexagonal paper cells. The shape of the comb, however, varies much with the species. In the two North American forms it hardly differs from that of *Polistes*, but in some of the Central and South American species it becomes very long and narrow, with the stalk at one end and the cells in one or two rows, sometimes placed chain-like one below the other.²⁷ The smaller nests are often attached to leaves. That of the Brazilian *M. artifex* Ducke imitates a dry crumpled-up leaf. The comb of *M. labiatus* is borne on a very long stalk.

According to Ducke, the species of *Mischocyttarus* are monogynous or haplometrotic wasps, which, strictly speaking, would mean that each colony is started normally by a single fertile female or queen. It is, however, not quite clear from published observations how the nests are actually started in nature. From my limited experience, I am inclined to believe that the founding of a new colony is essentially as in *Polistes*, that is, often or usually by a sin-

²⁷ Somewhat similar linear combs are also built by some species of the Old World genus *Ropalidia* (*Icaria*).

gle queen, but occasionally by a small number of fecundated females (not necessarily sisters). In any case, no true swarming has ever been observed in *Mischocyttarus*.

The colonies are always small. Males are often more numerous on the nests than females or workers, while in many other social wasps the reverse is true. The wasps are timid and, as a rule, make no attempt at defending the nest when disturbed. Sometimes they appear to rely on the protection given by ants, as in the case of *M. collaris* Ducke, which I observed near Manáos, Brazil, in August, 1924. Three small nests of this species were placed on the branches of a low bush, and when I attempted to take them, all the wasps flew away without attacking. The same bush, however, was settled by a large colony of the ant, *Dolichoderus* (*Hypoclinea*) *abruptus* (Smith) (named by Dr. W. M. Wheeler), which had built brown paper covers over the under side of most of the leaves. When the bush was disturbed, the ants became very angry, running over all the branches and biting furiously, whenever given a chance.

Mischocyttarus flavitarsis (H. de Saussure)

Text Figures 2 and 3. Plate XXIX, Figures 1 to 4

Specific Characters.—*Queen and Worker*.—Head much swollen; seen in front, about as wide as high; seen from above, broadly rectangular and about twice as wide as long; occipital margin very slightly curved inward. Vertex and genae not margined by a carina behind. Genae well developed, in profile about as wide as the eye. Oculo-malar space moderately long, about the length of the seventh antennal segment. Inner orbits about as far apart at the clypeus as on the vertex. Ocelli small, almost in an equilateral triangle; posterior ocelli about as far from the occipital margin as from the inner orbits, but less than half as far apart. Clypeus trapezoidal, at its lower margin nearly one and one-half times as wide as long, contiguous with the inner orbits over a rather short distance (equal to about the length of the oculo-malar space); median lobe of anterior margin moderately projecting, very broadly triangular, with extremely blunt, almost truncate apex, divided by rather deep, broad notches from the slightly projecting lateral lobes. Mandibles short, about one and one-half times as long as wide, with subparallel sides; outer surface very slightly convex; cutting edge slightly oblique, with four teeth, of which the upper one is much shorter and broadly truncate, the three lower ones acute and about equal. Antennae: scape slender, nearly straight, about four times as long as thick at

apex and about as long as the two following segments together; third segment three and one-half times as long as wide at apex, slightly longer than the fourth and fifth together; fourth and fifth longer than wide; sixth and seventh about as long as wide; eighth to eleventh distinctly wider than long; twelfth slightly longer than wide at base; flagellum only slightly and very gradually swollen apicad of the third segment. Thorax as usual in the genus; anterior margin of pronotum straight, very slightly swollen, not carinate; humeral angles, seen from above, broadly rounded and not in the least projecting; mesepisternal suture complete, well marked; propodeum with a broad and deep, median depression in its apical two-thirds, connected above with the postscutellum by means of a narrow, superficial groove. First abdominal tergite much narrower than the remainder of the abdomen, forming a very long and slender petiole; seen from above, it is about three times as long as wide at apex, much shorter than the thorax, but slightly longer than the second tergite; basal half parallel-sided, apical half gradually widened, the apical margin being nearly two and one-half times as wide as the base; spiracles very slightly protuberant on the sides, placed about midway of the tergite; in profile, the petiole is less than two-thirds the length of the thorax, very gradually swollen in its apical half, where it is not much more than one and one-half times as thick as at the base. Legs long and slender, the femora not markedly swollen; tibiae slender at base, much thicker in apical two-thirds; digitiform process on inner side of fourth segment of mid and hind tarsi moderately long, not quite reaching half the length of the fifth segment; apex of third segment of mid and hind tarsi slightly longer on the inner side; claws of mid and hind legs very slightly asymmetrical; mid tibiae with two spurs. Body dull, with the usual microscopic, alutaceous sculpture, which is somewhat coarser than in related species; clypeus with a few, scattered, fine punctures, its apex and the mandibles with more numerous, coarser punctures; otherwise impunctate. Pubescence as usual in the genus. Venation as usual in the genus, differing hardly from that of the genotype, *M. labiatus* (Fabricius).

Male.—Differs from the queen and worker only in the following points: oculo-malar space about two-thirds the length of the seventh antennal segment; face mask-like; clypeus subrectangular (thus appearing more distinctly wider than long), its surface fused with that of the frons over part of its upper margin; its lower margin very slightly protruding, forming a very even, shallow bow; mandibles shorter and broader, somewhat swollen, the lower margin somewhat convex about the

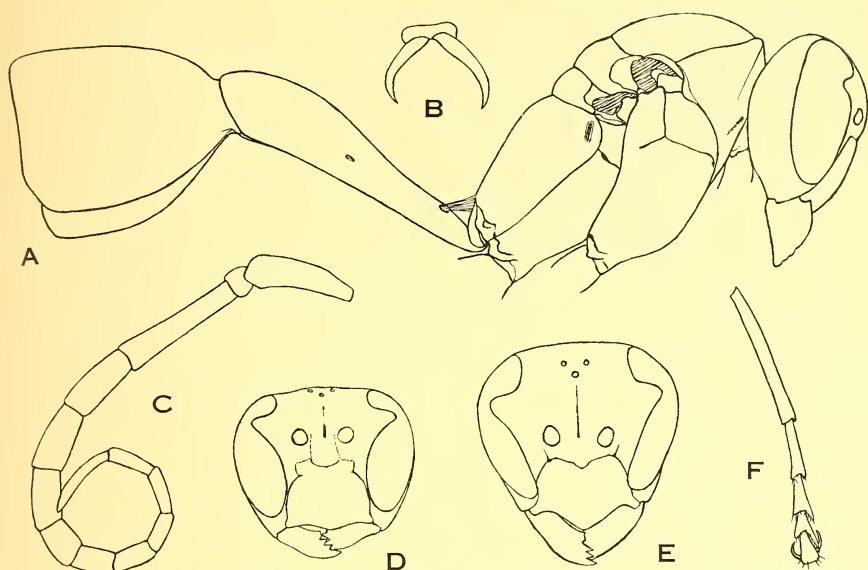


FIG. 2. *Mischocyttarus flavitarsis* var. *navajo* J. Bequaert: A, body of female in profile; B, hind claw of female; C, antenna of male; D, head of male; E, head of female; F, hind tarsus of female.

middle, the four apical teeth unequal in length, the lower tooth being much the longest. Antenna: scape much more swollen, less than three times as long as thick at apex, shorter than the third antennal segment; flagellum long, slightly and very gradually thickened from base to seventh antennal segment, then rather rapidly narrowed to the tip, with a decided tendency to curl up, though not forming a close coil; third antennal segment very long, almost as long as the fourth and fifth together; succeeding segments all much longer than thick, becoming very gradually shorter from the fourth to the ninth, then again gradually longer to the twelfth; the thirteenth very long and cylindrical, nearly straight, with broadly rounded apex, about as long as the fourth segment; none of the segments are flattened on the inner side, nor do they bear swellings or ridges; seventh tergite and sternite broadly rounded at apex; the tergite normally convex; the sternite slightly flattened in its apical half; second abdominal segment shorter and broader than in the female.²⁸

²⁸ H. de Saussure (1853-1855) knew only the female of the typical form. The male of this form was known to Lewis (1897), but he stated merely that it "very closely resembles the ♀." The

Length (h. + th. + t.1 + 2), of typical form and most varieties: queen and worker, 11 to 15 mm.; male, 11 to 13 mm. The var. *navajo* is on the average larger, measuring in queen, worker, and male, 12 to 17 mm. (h. + th. + t.1 + 2). Length of fore wing, 12 to 18 mm.

Coloration.—Any large collection of *M. flavitarsis* exhibits considerable variation in color, and some of the variants are so strikingly different that one might at first be inclined to regard them as distinct species. However, even the most careful study lends no support to this surmise, as it is impossible to correlate structural differences with the color variations. Viereck (1906, Trans. Amer. Ent. Soc., XXXII, p. 231) first recognized that "there are at least three types of coloration in this species representing, perhaps, as many races, of which the dark form is apparently one." C. L. Hayward (1930, Ent. News, XLI, p. 222; 1932, Proc. Utah Ac. Sci., IX, p. 88) also called attention to the variability of this wasp and, in addition, pointed out that specimens from a given locality often have a marked likeness in color. With the rather extensive material before me, and taking in consideration the geographical distribution of the several variants, I have been led to recognize by name the five color variants of the subjoined key.

KEY TO COLOR FORMS (QUEENS AND WORKERS)

1. Wings strongly infuscated, with pronounced purplish effulgence 2.
- Wings moderately clouded, amber-yellow with russet veins and costal cell; usually darker and slightly purplish in the radial cell 3.
2. Thorax black, without or with few ferruginous blotches and with reduced yellow markings. Petiole as a rule black or slightly brownish (rarely ferruginous), with broad yellow apex; remainder of abdomen mostly yellow. (Southern Arizona).
var. *navajo* J. Bequaert.
- Ground color of body ferruginous, with mere traces of black. Yellow markings of thorax reduced. Yellow fasciae of abdomen rather narrow, mostly replaced by ferruginous. (Northern Arizona) var. *kaibabensis* J. Bequaert.
3. Black color partly or mostly replaced by red or ferruginous red (at least the petiole or first tergite mostly ferruginous, except for the apical yellow fascia); in extreme cases the

first description of the male was by Ducke (1908), who saw specimens from Colorado, New Mexico and Arizona, therefore not of the typical color form.

thorax wholly ferruginous with yellow spots; base of second tergite as a rule extensively ferruginous. (Southern Utah and Colorado to New Mexico) var. *centralis* J. Bequaert.

Ferruginous color usually absent or restricted to blotches on the base of the second tergite (toward the yellow area); petiole or first tergite black, with an apical yellow fascia which is often somewhat brownish or reddish anteriorly.....4.

4. Bright yellow color very extensive: abdomen behind the petiole mostly of that color (except for the narrow reddish and black base of second segment); yellow spots of thorax large (usually present on mesopleura and coxae). (Oregon, California, Utah, Colorado and Nebraska).

typical *flavitarsis* (de Saussure).

Yellow markings much reduced: abdominal segments with fairly narrow, apical yellow fasciae; thoracic spots small (those of mesopleura and coxae as a rule lacking). (Utah, Oregon, Montana, Idaho, Washington State and British Columbia.)

var. *idahoensis* J. Bequaert.

Three of the five varieties recognized in this key are much less marked in the male sex. I have not seen enough males to reach definite conclusions; but it would seem that in that sex the black color is as a rule more extended than in the corresponding queens and workers from the same locality. The male of the var. *navajo* is as distinct as its female; that of the var. *kaibabensis* is as yet unknown. A thorough study of color variation within the colony, covering all queens, workers and males, caught on or bred from each nest, would help much toward clearing up the several variants of the species.

Distribution. (Text Figure 3).—In its several color variants, *M. flavitarsis* occurs over most of the United States west of the 100th Meridian, this wasp being one of the characteristic insects of that territory. I have seen it from Washington State, Oregon, California, Idaho, Montana, Utah, Arizona, Colorado, New Mexico, eastern Nebraska and eastern Texas. It undoubtedly will be found in Nevada and Wyoming; perhaps also in the eastern Dakotas, eastern Kansas and northeastern Oklahoma. The northernmost locality known to me is Lillooet, British Columbia (50° 43' N.; 121° 56' W.); the southernmost record is from the Chisos Mts., Brewster Co., Texas (in about 29° N. lat.). The only Mexican locality thus far is "Meadow Valley," somewhere in northern Chihuahua, close to the border of New Mexico. There is little doubt, however, that this wasp occurs in various other localities of the Mexican States of Coahuila, Chihuahua, and Sonora. It is found quite generally

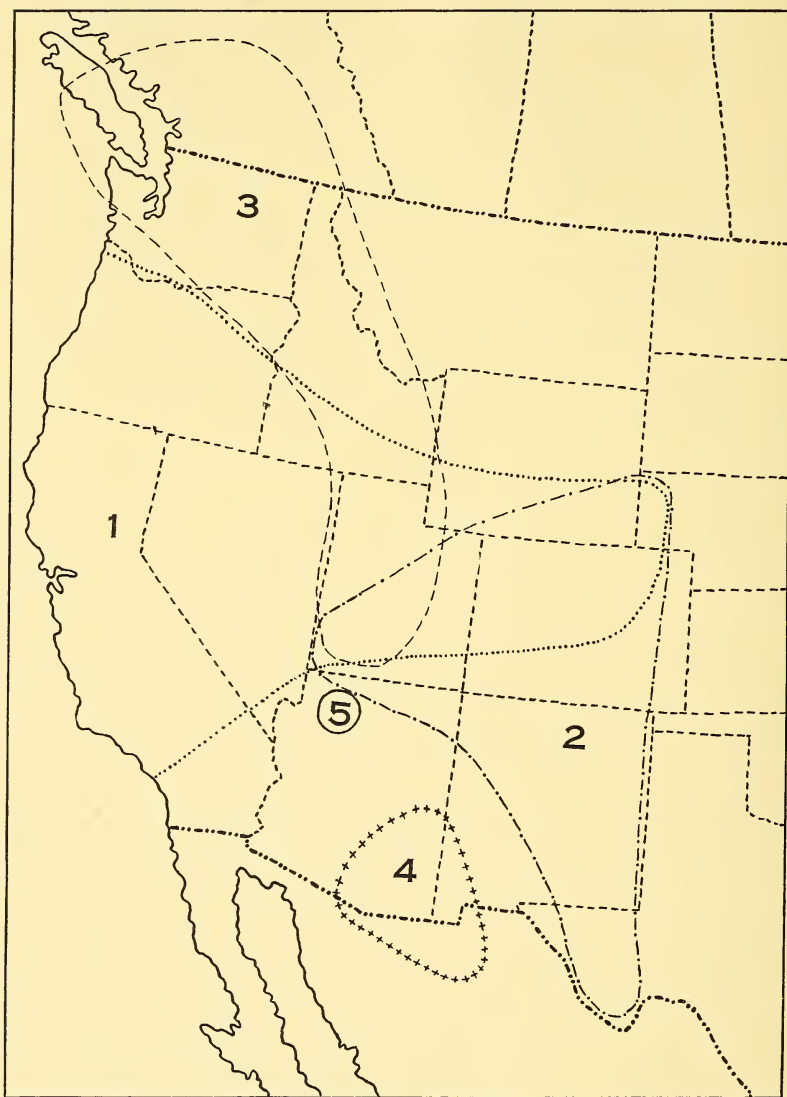


FIG. 3. Distribution of the several color forms of *Mischocyttarus flavitarsis* (H. de Saussure) in western North America: 1, typical form; 2, var. *centralis* J. Bequaert; 3, var. *idahoensis* J. Bequaert; 4, var. *navajo* J. Bequaert; 5, var. *kaibabensis* J. Bequaert.

from sea-level to about 8,000 ft.; it is doubtful whether it nests above that altitude. In the northern part of the range (in Idaho and Utah, for instance), it does not appear to extend as high up the mountains as farther south.

The typical (or first described) color variant is decidedly xanthic and, of the several forms, covers the largest area, including Oregon, California, Utah and Colorado. Although characteristic of the Pacific Coast Region, farther east it enters territory occupied also by two other variants (var. *idahoensis* and var. *centralis*), with which, moreover, it intergrades. The melanic form (var. *idahoensis*) extends farthest north, being found mainly in the Upper Sonoran and to some extent in the Transition life zones. The erythric form (var. *centralis*) seems to inhabit chiefly the Upper Sonoran life zone of Utah, Colorado, Nebraska, New Mexico, and eastern Texas. In the Upper Sonoran xerophytic forest of the mountain ranges of southeastern Arizona this erythric form is replaced by a most peculiar variant (var. *navajo*), which, perhaps more than any of the other forms, might claim to rank as a geographical race or subspecies. The var. *kaibabensis* is equally striking, but known thus far only from the Grand Canyon, in northwestern Arizona. Moreover, the possible correlation of the several variants with the different life zones or ecological vegetation types, as summarily sketched above, needs to be investigated much more carefully on the spot. It is, for instance, at present impossible to tell which ecological environment is favored by the typical form in California. From the records available to me, it would seem to inhabit chiefly the Transition zone, perhaps also the Upper Sonoran, and to be absent from the Lower Sonoran.

Ethology.—Few observations on the habits of *M. flavitarsis* are available. Essig (1926) says that it builds small, single-combed, unenveloped paper nests, usually smaller than *Polistes*, under rocks, logs, caves, banks and in buildings, and that the food consists largely of insects. C. L. Hayward (1932) states that it is "very similar in habits to the members of the genus *Polistes*. The nests are very similar in structure, although the colonies of *Mischocyttarus* are generally smaller."

Professor H. A. Scullen writes me that, in the vicinity of Corvallis, Oregon, the nests are rare: "This last spring (1932) a female of *M. flavitarsis* started her nest between the covers of one of my bee hives. I endeavored to disturb her as little as possible, but evidently the frequent interruption of her work discouraged her and she disappeared." This observation, relating to the typical

color variant, is of interest, because it indicates that this species is haplometrotic or monometrotic, a single fertile female (or queen) starting the new nest after hibernation.

A nest of the var. *navajo* was found at Mud Springs, Pine Canyon, Santa Catalina Mts., Arizona, in the latter half of July, 1916, by Dr. F. E. Lutz, at an altitude of 6,800 ft. The vegetation of the region consisted of oak, pinyon pine, juniper, walnut and a slight sprinkling of *Agave*. (Shelford's "Xerophytic Coniferous Forest," in Merriam's "Upper Sonoran Life Zone.") Dr. Lutz's field notes state that "the nest was placed under the over-hanging dead blades of a clump of bunch grass and was completely hidden." It evidently was built a short distance from the ground. It consists of a single, almost flat comb of paper cells, about 38 mm. long, 25 mm. wide and 20 mm. high (this being the height of the largest cell). There are about 45 cells, which reach about 5 mm. in diameter when completed; but most of the cells are rather short or barely started. The nest is built of a tough, coarse, gray paper similar in appearance, material, and texture to that of *Polistes fuscatus* var. *pallipes*. It very distinctly consists of wood fibres. Most of the cells were empty, but one contained a pupa, and this cell had been capped over with a thin membrane evidently made by the full-grown larva. The short stalk is eccentric, placed at the upper end, so that the hanging comb is almost vertical, the cells at the upper end being horizontal, those at the lower end vertical and opening downward. Photographs of this nest are reproduced in Plate XXIX, Figures 1 and 2.

A nest of the typical form of the species was received from Professor H. A. Scullen, who found it near Corvallis, Oregon, August 18, 1924. It is similar to the foregoing, 45 mm. long, 25 mm. wide and 18 mm. high, of about 55 cells, most of them completed. The stalk was placed about the middle of the length, but slightly to one side. Figures 3 and 4, of Plate XXIX, are photographs of this nest, which unfortunately was rather poorly preserved.

The larva and pupa are not available for description.

M. flavitarsis appears to be much subject to the attacks of parasites of the order Strepsiptera. W. D. Pierce (1918, Proc. U. S. Nat. Mus., LIV, p. 490) records a stylopized specimen from Stone Cabin Canyon, Santa Rita Mts., Arizona (evidently of the var. *navajo*, although I have not seen it). In the several collections studied, I have found the following stylopized examples:

1. Female of var. *centralis*; Cimarron, Colorado; with four ♂: t. 3, l; s. 3, r.; s. 4, l; s. 5, r.

2. Female of var. *centralis*; Bryce Canyon, Utah; with one ♀: t. 4, 1.

3. Female of var. *centralis*; Jemez Springs, New Mexico; with one ♀: t. 4, 1.

4. Female of var. *centralis*; Jemez Springs, New Mexico; with one ♀: t. 4, 1.

5. Female of var. *navajo*; Fort Grant, Arizona; with one ♀: t. 4, r.

6. Female of var. *navajo*; Oak Creek Canyon, Arizona; with six males and one female: t. 3, two; s. 3, one; t. 4, two; s. 4, one; t. 5, one.

A careful comparative study of these stylopized females fails to show any appreciable tendency toward male characters, either in structure or in color.

M. flavitarsis, typical form

Polybia flavitarsis H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 199 (♀; California; holotype in British Museum). F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 130, Pl. V, fig. 1. Walsh and Riley, 1869, Americ. Entom., I, p. 142. Cresson, 1887, Trans. Amer. Ent. Soc., Suppl. Vol., p. 290. Dalla Torre, 1894, Cat. Hym., IX, p. 163; 1904, Gen. Insect., Vesp., p. 77. Lewis, 1897, Trans. Amer. Ent. Soc., XXIV, p. 190, Pl. I, fig. 3 (♀ ♂). Kellogg, 1905, American Insects, 1st Ed., p. 507; 1908, *Ibid.*, 2d Ed., p. 507.

Megacanthopus (?) *flavitarsis* Ducke, 1907, Bol. Mus. Goeldi, Pará, V, p. 190.

Megacanthopus flavitarsis Meade-Waldo, 1911, Ann. Mag. Nat. Hist., (8) VII, p. 111.

Mischocyttarus (*Myrapetra*) *flavitarsis* Essig, 1926, Insects of Western North America, p. 888, fig. 750 (♀).

The foregoing references refer exclusively to the typical form of the species; but the following were based upon a mixture of several of the varieties here recognized.

Megacanthopus flavitarsis Ducke, 1908, Deutsch. Ent. Zeitschr., p. 698 (♀ ♂; from Colorado, New Mexico and Arizona).

Mischocyttarus flavitarsis Hayward, 1930, Ent. News, XLI, p. 222 (♀ ♂; from Utah, California, Arizona and Idaho); 1932, Proc. Utah Ac. Sci., IX, p. 88, Pl. IX, fig. 30 (from Utah, Idaho and Arizona).

Specimens Examined.—CALIFORNIA: Giant Forest, Tulare Co. (R. C. Shannon); Pasadena, Los Angeles Co.; Arroyo Seco, S.

Pasadena; Claremont, Los Angeles Co.; Mt. Wilson, Los Angeles Co.; San Antonio Canyon, N. of Ontario, San Bernardino Co., 3,950 ft.; S. fork of Kaweah R., Tulare Co., below 6,500 ft.; Santa Barbara, Santa Barbara Co.; Felton, Sa Cruz Mts., Sa Cruz Co., 300-500 ft.; Stanford University; Palo Alto, San Mateo Co.; San Clemente, Marin Co.; Watsons, Sonoma Co.; Cazadero, Sonoma Co.; Mt. Shasta district, Siskiyou Co.—OREGON: Eleven miles north of Grants Pass, Josephine Co., 1,350 ft.; Grave Creek, Josephine Co.; Eugene, Lane Co.; Corvallis, Benton Co.; Silverton, Marion Co.; McKenzie Bridge; Coe's Valley; Hugo.—UTAH: Beaver Canyon, Beaver Creek Hills, and Wildcat Valley, Beaver Co.; Springville, Utah Co.; Rock Canyon, Provo, Utah Co.; Salt Lake City; Ogden, Weber Co., 4,300 ft.; Logan, Cache Co.; Raft River Mts., Boxelder Co., 10,000 ft.; Dividend, Utah Co.—COLORADO: Boulder, Boulder Co., 5,500 ft.; Jim Creek near Boulder, 4,795 ft.; Springdale, Boulder Co., 5,580 ft.; Platte Canyon, Jefferson Co.; Glenwood Springs, Garfield Co., 5,800 ft.; Palisades, Mesa Co., 4,740 ft.; Ft. Collins, Larimer Co.; Poudre River, Larimer Co.—NEBRASKA: Sioux Co.

H. de Saussure described the color of the typical form as follows: "Head black; clypeus, mandibles, orbits, a V on the vertex, a triangle on the frons, yellow. Antennae orange; the first segment yellow anteriorly, somewhat dark above. Thorax black; the two margins of the prothorax, a spot beneath the wing, anterior margin of scutellum and postscutellum, and two pear-shaped spots on the propodeum, yellow. Tegulae russet. Abdomen yellow; base of second segment and petiole black; the petiole yellow at apex. Legs black; knees, tibiae and tarsi yellow, variegated with russet; coxae spotted with yellow. Wings ferruginous, the apex gray. The black area at the base of the second segment is rather irregular."

This description covers most of the extreme xanthic specimens, found throughout California and western Oregon; but the wings are yellowish rather than ferruginous, with the veins, the stigma and the costal cell ferruginous; the yellow of the knees often extends over part of the femora and may almost reach the base on the under side of the fore femora; usually the bases of mid and hind femora and their trochanters are spotted with yellow on the upper side. Exceptionally the mesonotum bears two curved, yellow lines, and there may be yellow spots on the lower part of mesopleura and on metapleura. In some of the Californian specimens the black base of the second segment turns reddish brown at the limit with the yellow.

Some of the specimens from Utah and Colorado differ from those from California only in the reduction of the yellow lines on the vertex or the absence of spots on the coxae. In others, however, many of the yellow markings of the thorax disappear, while the black base of the second segment is much broader. Such specimens are transitional between the typical form and the var. *idahoensis*. In Utah and Colorado also, the middle of the first and second tergites is often more or less brownish to ferruginous, such specimens forming the passage to the var. *centralis*.

In California, the males are even more abundantly marked with yellow than the females and workers. The head is almost entirely yellow, except for the black vertex and occiput (the occiput sometimes mostly yellow and the vertex as a rule with two oblique yellow lines). The under side of thorax, coxae, femora and petiole also is very extensively yellow.

In many males from Utah and Colorado, the yellow is much less extensive on the abdomen than in the workers and females taken in the same localities. It would seem that in that sex the typical form cannot be distinguished there from the var. *idahoensis*.

In California, typical *M. flavitarsis* is homeochromic with ("mimics") *Polistes fuscatus* var. *aurifer* (de Saussure), *Ancistrocerus sutterianus* de Saussure, and some other local insects.

M. flavitarsis var. **centralis**, new variety

Polybia flavitarsis Ashmead, 1890, Colorado Biol. Assoc. Bull. No. 1, p. 34 (Colorado). Viereck, 1903, Trans. Amer. Ent. Soc., XXIX, p. 68 (♂; Beulah, New Mexico).

Specimens Examined.—UTAH: Cedar City, Iron Co., one female paratype (I. N. Hayward.—B. Y. Univ.); Bryce Canyon, Garfield Co., one female paratype (V. M. Tanner.—M.C.Z.); Buckskin Valley, Iron Co., one female paratype (U.S.N.M.); Ute Mts., Uintah Co., one female paratype (V. M. Tanner.—B. Y. Univ.); Beaver Creek Hills, Beaver Co., two female paratypes (U.S.N.M.); Zion National Park, Washington Co., one female paratype (V. M. Tanner.—B. Y. Univ.); Moab, Grand Co., one female paratype (V. M. Tanner.—B. Y. Univ.); Jensen, Uintah Co., six female paratypes (G. Fairchild).—COLORADO: Glenwood Springs, Garfield Co., 5,800 ft., one female paratype (A.M.N.H.); Montrose, Montrose Co., one female paratype (A.M.N.H.); Animas, La Plata Co., 6,600 ft., one female paratype (A.M.N.H.); Boulder, Boulder Co., two female paratypes (H. Holt); Springdale, Boulder Co., 5,580 ft., one female paratype (T. D. A. Cockerell.—M.C.Z.); Custer Co., one

female paratype (T. D. A. Cockerell.—U.S.N.M.) ; Ft. Collins, Larimer Co., three female paratypes; Rifle, Garfield Co., one female paratype (S. A. Rohwer.—U.S.N.M.) ; Manitou, El Paso Co., three female paratypes (E. P. Van Duzee.—Cal. Acad. Sci. and U.S.N.M.) ; Mesa Verde, Montezuma Co., 6,600 to 8,000 ft., three female paratypes (J. Bequaert.—M.C.Z.; A.M.N.H.) ; Texas Creek, Fremont Co., one female and one male paratypes (R. C. Shannon.—Cornell Univ.) ; Cimarron, Montrose Co., one female paratype (R. C. Shannon.—M.C.Z.) ; Palisades, Mesa Co., 4,700 ft., one female paratype (C. L. Hayward).—NEBRASKA: Squaw Canyon, Sioux Co., two female paratypes (H. G. Barber.—M.C.Z.).—NEW MEXICO: Las Vegas, San Miguel Co., two female paratypes (Barber and Schwarz.—U.S.N.M.) ; Jemez Springs, Sandoval Co., one female holotype (M.C.Z.), one male allotype (M.C.Z.), fourteen female paratypes, and one male paratype (John Woodgate.—Cornell Univ.; M.C.Z.).—TEXAS: Chisos Mts., Brewster Co., eight female paratypes (Mitchell and Cushman.—U.S.N.M.) ; Limpia Canyon, Davis Mts., Jeff Davis Co., 5,000–5,500 ft., one female paratype and two male paratypes (J. C. Bradley.—Cornell Univ.).—Also seven female paratypes from Colorado, without definite locality (U.S.N.M.).²⁹

Queen and Worker.—This form is characterized by the partial replacement of black by ferruginous red. In the holotype, from Jemez Springs, New Mexico, most of the areas of the abdomen usually black have become ferruginous; on the thorax only the pronotum, scutellum and femora show a touch of reddish brown; the yellow markings are very extensive and much as in the typical form. Some of the paratypes from Jemez Springs show two ferruginous curved lines on the mesonotum. Most of the specimens from Utah and Colorado which I refer to the var. *centralis* differ little from the holotype; but one finds together with them specimens which differ from typical *flavitaris* only in having reddish blotches on the black base of the petiole. In one female from Moab, Utah, the black of the body is replaced almost everywhere by ferruginous (a large, irregular ocellar spot on the vertex and a narrow median line on the mesonotum are the only black areas left); this specimen differs from the var. *kaibabensis*, described below

²⁹ Since the MS was sent to the printer, additional paratypes of *M. f. var. centralis* have been seen from: Zion National Park, Utah, three females (R. H. Beamer and P. W. Oman); Colorado, one female; Manitou, Colorado, one female (E. S. Tucker); near Las Vegas Hot Springs, New Mexico, three females (F. H. Snow); Cloudcroft, New Mexico, four males (R. H. Beamer). All in Kansas Univ.

from the Grand Canyon, merely in the decided yellow tinge of the wings and the presence of yellow spots on pleura and pronotum.

The *males*, which from the geographical distribution should belong, at least partly, to the var. *centralis*, are not clearly characterized, since the ferruginous areas of the abdomen are more or less blotched with black, or even entirely replaced by that color.

The var. *centralis* is perhaps the most poorly defined of the several variants of the species. One finds it in several localities together with the typical form, and occasionally transitional specimens are met with. Yet it is so frequently seen in Colorado, Utah and New Mexico, while it is altogether unknown farther west and north, that it must have some significance as a geographic variation. I suspect that, like var. *navajo*, it is correlated with peculiar ecological conditions, which, however, I am unable to trace at present.

In Utah and Colorado, *M. flavitarsis* var. *centralis* is homeochromic with *Polistes fuscatus* var. *centralis* Hayward (1933, Proc. Utah Ac. Sci., X, p. 143).

M. flavitarsis var. *navajo*, new variety

Polybia flavitarsis Viereck, 1906, Trans. Amer. Ent. Soc., XXXII, p. 231 (♀; Oak Creek Canyon, 6,000 ft., Coconino Co., Arizona). Snow, 1907, Trans. Kansas Ac. Sc., XX, pt. 2, (1906), p. 131 (Oak Creek Canyon, 20 miles S.W. of Flagstaff, 3,000 ft.; and Baboquivari Mts., 3,750 ft., Pima Co., Arizona).

Meganthopus flavitarsis Pierce, 1918, Proc. U. S. Nat. Mus., LIV, p. 490 (Stone Cabin Canyon, Sa. Rita Mts., Sa. Cruz and Pima Cos., Arizona).

Mischocyttarus flavitarsis Salt and Bequaert, 1929, Psyche, XXXVI, p. 261.

Specimens Examined.—ARIZONA: Ramsey Canyon, Huachuca Mts., Cochise Co., thirteen female paratypes and one male paratype (J. C. Bradley and J. D. Hood.—Cornell Univ.); Post Creek Canyon, Fort Grant, Pinaleno Mts., Graham Co., 6,000 ft., one female holotype (M.C.Z.), one male allotype (M.C.Z.), sixteen female paratypes, and five male paratypes (J. C. Bradley and J. Bequaert.—Cornell Univ.; M.C.Z.); Palmerlee (or Garces), Cochise Co., seventeen female paratypes and fifteen male paratypes (C. R. Biederman.—A.M.N.H., M.C.Z., U.S.N.M., and Cornell Univ.); Kits Peak, Rincon, Baboquivari Mts., Pima Co., 4,050 ft., two female paratypes and one male paratype (A.M.N.H., M.C.Z.); Mud Springs, Sa. Catalina Mts., Pima Co., 6,500 ft., eight female para-

types collected on a nest (A.M.N.H.); Sabino Basin, Sa. Catalina Mts., Pima Co., 3,800 ft., eight female paratypes (A.M.N.H.); Apache Camp, Sa. Catalina Mts., Pima Co., 5,500 ft., two female paratypes (J. Bequaert.—M.C.Z.); Bisbee, Cochise Co., one female paratype (Curtis.—B. Y. Univ.); Cochise Co., one female paratype (V. W. Owen.—Cal. Acad. Sci.); Williams, Coconino Co., one male paratype (Barber and Schwarz.—U.S.N.M.). Also several female and male paratypes from Southern Arizona, without more definite locality (M.C.Z. and U.S.N.M.).—CHIHUAHUA (Mexico): Meadow Valley, one female paratype (C. H. T. Townsend.—U.S.N.M.; this locality, Prof. T. D. A. Cockerell tells me, is in the Sierra Madre, somewhere near the western border of the State of Chihuahua).³⁰

Queen and Worker.—Black, with yellow markings as follows: clypeus, under side of scape, lower inner orbits (up to the bottom of the ocular sinus), small spots on the face near the base of the antennae (the upper pair forming oblique lines), very broad outer orbits, two oblique lines on the vertex (converging behind), narrow anterior and posterior margins of pronotum (sometimes much broadened), anterior half or more of scutellum, narrow anterior margin of postscutellum, a small elongate spot in the upper edge of mesopleura, a spot at base of femora above, knees, apices of tibiae, tarsi, broad apical margin of first tergite (petiole), and most of abdomen behind the petiole (except the irregular, brownish black base of 2d segment). Mandibles, oculo-malar space, upper side of scape, basal half of flagellum and a line on the under side of its apical half, tegulae, and most of femora, ferruginous (usually more or less suffused with yellow). In some specimens the mesonotum bears two curved, orange-yellow or russet lines. On head and thorax the yellow is usually more or less orange, while on the abdomen it is as a rule much paler. Wings strongly infuscated, with a decided purplish effulgence; veins brownish black; stigma russet.

Male.—Head almost wholly pale yellow (except for the broad black vertex); under side of thorax, coxae and under side of femora extensively yellow; upper corner of mesopleura usually and propodeum sometimes spotted with yellow; abdomen either as in the female or the brownish-black base of the second segment more extensive.

³⁰ Since the MS was sent to the printer, I have seen 52 additional paratypes of *M. f.* var. *navajo* from: Southern Arizona; Sa. Rita Mts., 5,000 to 8,000 ft. (F. H. Snow); Oak Creek Canyon, 6,000 ft. (F. H. Snow); Baboquivari Mts. (F. H. Snow); Huachuca Mts. (R. H. Beamer); Chiricahua Mts. (R. H. Beamer); (all localities in Arizona). All in Kansas Univ.

This variety averages larger than the other forms of the species.

M. flavitarsis var. *navajo* is one of the characteristic members of the Upper Sonoran fauna in the xerophytic forest of junipers, pinyons and evergreen oaks, between 5,000 and 7,000 ft., on the slopes of the several small mountain ranges of southeastern Arizona. Here it is one of a group of insects that exhibit a remarkable parallelism, or deceptive resemblance, in coloration. This homeo-chromic group includes also the wasps, *Polistes canadensis* var. *navajo* (Cresson) and *Ancistrocerus navajo* J. Bequaert, as well as the syrphid fly, *Sphiximorpha loewii* (Williston). I have taken these three insects, flying together with *M. flavitarsis* var. *navajo*, in Post Creek Canyon, at an altitude of about 6,000 ft., July 17, 1917.

M. flavitarsis var. **kaibabensis**, new variety

Specimens Examined.—ARIZONA: Bright Angel Trail, Grand Canyon, Cococino Co., one female, holotype (Cornell Univ.) and one female paratype (M.C.Z.); both collected by R. C. Shannon, on the Cornell Biological Expedition, August 4, 1917.

Queen and Worker.—The extreme erythric form of the species. Body bright ferruginous red; only the edge of the clypeus, the teeth of the mandibles, and the sutures of scutellum and postscutellum blackish; with rather reduced yellow markings as follows: clypeus, lower half of face, broad outer orbits, mandibles, two oblique lines on vertex, narrow anterior and posterior margins of pronotum, a diffuse spot in the upper corner of the mesopleura, most of scutellum and postscutellum, tegulae, apices of femora, most of tibiae and tarsi, and moderately wide apical fasciae on all abdominal segments (gradually passing into the ferruginous areas); base of antennae and under side of coxae and femora somewhat yellowish. Wings strongly infusate, with a purplish tinge; stigma and veins russet; base of wing and a diffuse blotch beneath the stigma clearer, more yellowish; extreme apical margin of fore wing subhyaline.

The var. *kaibabensis* is a perfect parallel in color (or "mimic") of *Polistes canadensis* var. *kaibabensis* Hayward, which occurs in the same district. It is chiefly for this reason that I have given it a name. It evidently combines the erythric tendency of the var. *centralis* with the peculiar coloration of the wing of the var. *navajo*.

M. flavitarsis var. **idahoensis**, new variety

Specimens Examined.—WASHINGTON STATE: Blewett Pass, Chelan Co., one female paratype (A. L. Melander.—M.C.Z.); Lake

Chelan, Stehekin, Chelan Co., one female paratype (A. L. Melander.—M.C.Z.).—OREGON: Wallowa Lake, Wallowa Co., 4,500 to 5,500 ft., one female paratype (H. A. Scullen).—IDAHO: Warren, Idaho Co., one female holotype and one female paratype (M.C.Z.).—UTAH: Springville, Utah Co., one female and one male, paratypes (C. L. Hayward.—B. Y. Univ.); Rock Canyon, Provo, Utah Co., four female paratypes (C. L. Hayward.—B. Y. Univ.); Provo, Utah Co., one female paratype (C. L. Hayward.—B. Y. Univ.); Cedar City, Iron Co., one male allotype (I. N. Hayward.—M.C.Z.).—BRITISH COLUMBIA: without more definite locality, one female paratype (Can. Ent. Coll.); Victoria, Vancouver Island, seven female paratypes and one male paratype (W. B. Anderson; G. J. Spencer; R. C. Treherne; H. Hugh; K. F. Auden; R. Glendenning.—Can. Ent. Coll.); Sooke Rock, Vancouver Island, six female paratypes (W. B. Anderson.—Can. Ent. Coll.); Danby, Vancouver Island, one female paratype (Can. Ent. Coll.); Goldstream, Vancouver Island, one female paratype (Tom Wilson); Lillooet, one female paratype and two male paratypes (A. W. Phair; W. B. Anderson.—Can. Ent. Coll.); Oliver, 1,200 ft. (40 miles S. of Penticton), six female paratypes (C. B. Garrett.—Can. Ent. Coll.); Nanaimo, one female paratype (G. J. Spencer); Keremeos, eight female paratypes (W. B. Anderson; G. B. Garrett.—Can. Ent. Coll.); Thompson River, three female paratypes (T. Wilson.—Can. Ent. Coll.); Osoyoos, two female paratypes (Can. Ent. Coll.); Summerland, two female paratypes (F. W. L. Sladen.—Can. Ent. Coll.); Kelowna, one male paratype (C. G. Hewitt.—Can. Ent. Coll.); Vernon, one female paratype (E. P. Venables.—Can. Ent. Coll.); Lytton, two female paratypes (W. B. Anderson.—Can. Ent. Coll.; and G. J. Spencer); West Bank, two female paratypes (E. R. Buckell); Okanagan Falls, ten female paratypes (F. W. L. Sladen; E. M. Anderson.—Can. Ent. Coll.); Vancouver (city or island?), one female paratype and one male paratype (C. F. Baker Coll.—U.S.N.M.); Vancouver City, two male paratypes (G. J. Spencer).³¹

Queen and Worker.—This is the dark, or melanic, form of the species. The holotype (from Warren, Idaho) is black with the following parts yellow: clypeus; narrow lower inner orbits

³¹ Since the MS was sent to the printer, I have seen additional paratypes of *M. f.* var. *idahoensis* from: Weeksville, Sanders Co., Montana, one female (S. Henshaw and H. Hagen.—M. C. Z.); Salt Lake City, two males (J. Nottingham); Weber Canyon, Utah, one female, (L. D. Anderson); Lytton, B. C., three females (R. H. Beamer); Vernon, B. C., one female (J. Nottingham). All in Kansas Univ., except the first.

(reaching the bottom of the ocular sinus); a small frontal, oblique mark near the base of each antenna; broad outer orbits; narrow anterior and posterior margins of pronotum; moderately broad anterior margin of scutellum and postscutellum; a narrow, wedge-shaped spot in the lower half on each side of the propodeum; apical fasciae on all abdominal tergites and sternites (narrowest on 1st, 2nd and 3rd; that of the second tergite covering in the middle about one-fourth of the length, much broadened along the sides; the fasciae on 2d and 3d segments are bi-emarginate or bear a pair of blackish spots); broad apices of femora; and most of tibiae and tarsi. Antennae (except the yellow under side of the scape), lower third of clypeus, mandibles, oculo-malar space, tegulae, under side of tibiae, and claws, reddish brown to ferruginous. Wings as in the typical form. Many of the specimens from Washington State, Utah and British Columbia, which I refer to this variety, have broader yellow fasciae on the abdomen (covering about half of the 2d tergite), but the markings of head, thorax and legs are much as in the holotype. In British Columbia the outer orbits are sometimes only very narrowly yellow, while the clypeus may be mostly black, with or without median yellow spots. The darkest specimens seen are from Sooke Rock, Vancouver Island. Exceptionally part of the second abdominal tergite is somewhat ferruginous.

Male.—More extensively yellow than the female, the head (except for the broad black vertex), the under side of the thorax, and the anterior half of the mesopleura of that color. Legs mostly yellow, except for the black upper side of the femora; in some males the femora are black with a narrow yellow line beneath. Antennae mostly orange yellow, the upper side of the scape black.

The var. *idahoensis* undoubtedly occurs also in Wyoming, a state whence I have seen no *Mischocyttarus* thus far. Much of the area occupied by this color form (notably in southeastern Idaho, northeastern Utah, northwestern Colorado and southwestern Wyoming) is also inhabited by a race of *Polistes fuscatus*, extremely similar in color pattern. This homeochromic *Polistes* was sent to me by Mr. C. Lynn Hayward, who described it recently as *P. fuscatus* var. *utahensis* (1933, Proc. Utah Ac. Sci., X, p. 142). Another homeochromic wasp of Utah is the psammocharid, *Batazonus flavipennis* N. Banks.

Mischocyttarus cubensis (H. de Saussure)

Text Figure 4. Plate XXIX, Figures 5 and 6

Specific Characters.—*Queen and Worker*.—Head transverse, slightly wider than the thorax; seen in front, wider than

high; seen from above, rectangular and not quite three times as wide as long; occipital margin rather strongly curved inward in its median half. Vertex and genae not margined by a carina. Genae well developed and moderately swollen behind the eyes, in profile distinctly narrower than the eyes. Oculo-malar space very short, though present, but much less than the length of the eighth antennal segment. Inner orbits distinctly farther apart on the vertex than at the clypeus. Ocelli large, in an equilateral triangle; posterior ocelli about as far from the eyes as from the occipital margin, but much nearer to each other. Clypeus slightly wider than long, transversely pentagonal, contiguous with the inner orbits over a little less than half the upper lateral margins; median lobe of anterior margin moderately projecting and not deeply separated from the rather inconspicuous lateral lobes; the apex itself broadly obtuse. Eyes usually bare; sometimes with a few, minute, much scattered hairs, visible only with high magnification. Mandibles moderately long, about twice as long as wide, with subparallel sides; outer surface very slightly convex; cutting edge slightly oblique, with four teeth, of which the upper one is much smaller, the three lower ones about equal. Antenna: scape slender, nearly straight, slightly more than three times as long as thick at apex and about as long as the two following segments together; third segment much longer than the fourth and fifth together; fourth slightly longer than wide; fifth about as long as wide; sixth to eleventh distinctly wider than long; twelfth slightly longer than wide at base; flagellum distinctly swollen apicad of third segment. Thorax as usual in the genus; anterior margin of pronotum slightly curved, much raised and carinate on the sides; humeral angles, seen from above, distinctly projecting, though blunt; mesepisternal suture complete, well marked; propodeum with a rather shallow and broad longitudinal groove. First abdominal tergite much narrower than the remainder of the abdomen, forming a long and slender petiole; seen from above, about three times as long as wide at apex, considerably shorter than the thorax, but distinctly longer than the second tergite; narrow basal half parallel-sided; apical third, seen from above, about twice as wide as the base into which it passes quite gradually; spiracles slightly protuberant on the sides and placed about midway of the tergite; in profile, the petiole is very gradually swollen posteriorly, where it is a little thicker than at the base. Legs long and slender; femora not appreciably swollen; digitiform processes of the mid and hind tarsi long, those of the fourth segment reaching much beyond the middle of the fifth segment; claws of mid and hind legs

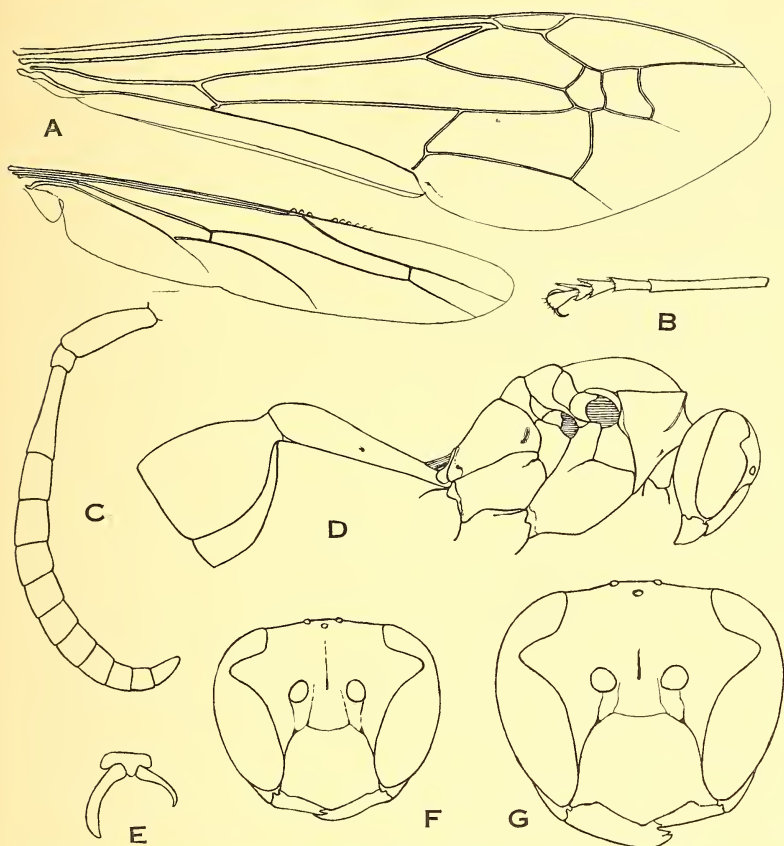


FIG. 4. *Mischocyttarus cubensis* (H. de Saussure): A, wings of female; B, hind tarsus of female; C, antenna of male; D, body of female in profile; E, hind claw of female; F, head of male; G, head of female. Female from Trinidad Mts., Cuba; male from St. Simon's Island, Georgia.

strongly asymmetrical, one of the claws in each pair nearly twice as long as, and much thicker than, the other; mid tibiae with two spurs. Body dull, with microscopic, alutaceous sculpture; under a hand-lens it appears to be impunctate, except for a few coarse pits on the median, apical lobe of the clypeus and on the mandibles. Pubescence very fine, short and appressed; apical third of clypeus, mandibles, and outer surface of tibiae with longer and stouter erect hairs; hind tibiae with the usual brush of shiny hairs on the under side near the apex. Venation as usual in the genus.

Male.—Differs from the queen and worker only in the following points: head hardly emarginate behind; genae shorter and not swollen behind the eyes, not quite half as wide as the eye in profile; upper lateral margins of clypeus touching the eyes over about two-thirds of their length, the lower lateral margins forming almost straight lines from the bases of the mandibles to the broadly curved apex which projects very little; antenna more slender, of thirteen segments: scape relatively more swollen and about as long as the third segment; fourth to thirteenth segments slightly flattened on the under side over a narrow area; twelfth about as long as wide; thirteenth conical, bluntly pointed at apex, one and one-third times the length of the twelfth; flagellum straight, not curled; seventh abdominal tergite and sternite broadly rounded at apex, the tergite normally convex, the sternite slightly flattened in its apical half.

Length (h + th. + t. 1 + 2): queen and worker, 8 to 11 mm.; male, 8 to 10.5 mm. Length of fore wing, 7.5 to 12 mm.

Coloration.—After studying considerable material of Central American *Mischocyttarus*, I have reached the conclusion that de Saussure's *Polybia mexicana* was based upon a color variant of *M. cubensis*. At any rate, I am unable to find any structural characters, in either sex, that would enable one to separate the Mexican and Central American specimens which I refer to *mexicana* from *cubensis* of Florida and Cuba.

The queens and workers of the two color forms may be separated as follows:

KEY TO COLOR FORMS

- Ground color of head, thorax and abdomen rather uniformly reddish brown, exceptionally with a few black blotches (more often on the propodeum and pectus). Pleura and pectus spotted with yellow, but not mostly of that color. Wings extensively tinged with amber yellow and usually darkened in the radial cell typical *cubensis*.
- Ground color of vertex and mesonotum blackish brown to black, generally contrasting with that of the abdomen which varies from orange yellow through ferruginous to blackish brown. Pleura and pectus often almost entirely yellow. Wings nearly hyaline var. *mexicanus* (H. de Saussure).

The male of the typical form differs little in color from the queen and worker; but of the few males of the var. *mexicanus* I have seen, some are colored like the worker, while others have the

abdomen dorsally blackish brown with apical yellow fasciae (extending along the sides of the tergites and angularly expanded on the sides of the second tergite) and ventrally almost wholly yellow.

Distribution.—Typical *M. cubensis* occurs in southeastern Georgia, throughout Florida (except the northwestern portion), the Bahamas and Cuba, and possibly in Jamaica. It is fairly common over most of this territory; but there are as yet very few records from the Bahamas. References to *M. cubensis* from Santo Domingo and Porto Rico are, in my opinion, based upon erroneous identifications, since all the specimens I have seen from those islands (as well as from St. Croix) were *M. phthisicus* (Fabricius).

On the American continent, *M. cubensis* var. *mexicanus* is known thus far only from southern Mexico, Guatemala, and the Republic of Honduras; but quite likely it is more widely distributed. It seems, however, to be restricted to the Atlantic drainage. At present it is not known how far north it extends.

Ethology.—Our knowledge of the habits of *M. cubensis* is as yet very meager. Cresson (1865) mentioned that the nest of the typical form, in Cuba, is in general shape similar to that of *Icaria variegata* H. de Saussure (1853, Et. Fam. Vesp., II, P. 25, Pl. IV, figs. 3–3a; this was *Icaria artifex* H. de Saussure, not *I. variegata* F. Smith), from Java. Ashmead (1894) noted that, in Florida, *M. cubensis* builds a papery comb (like that of *Polistes*), not enclosed in a covering, and attached to a twig of a low tree.

A beautiful nest of typical *cubensis* (Pl. XXIX, Figs. 5 and 6) was collected by G. B. Fairchild and D. M. Bates at Baragua, Cuba, June 20, 1932. It was found at the wooded, swampy margin of a stream, hanging down from Spanish moss (*Tillandsia*) some six feet above the ground. From below, the single, openly exposed comb is irregularly oval in outline, 28 mm. long and 21 mm. wide. In profile, it is cap-shaped, the peripheral cells starting at lower levels than those of the center. The short and thin stalk is about central and the nest was placed vertically, with all cells opening downward. There are some 37 cells in all, most of them incomplete. Four of the cells are capped over, but they are of very unequal height (15, 13, 11 and 10 mm. respectively). When completed, the hexagonal cells are 3.5 mm. across. The nest is pale brown, solid and of a coarser texture than that of *M. flavitarsis*. The material of which it is built contains very few fibers, but consists rather of flat pieces of plant tissue, probably taken from leaves and not from wood. Four female wasps, all exactly of the same size, shape and color, were found resting on the comb.

I have taken the male at flowers of *Lantana Camara* Linnaeus, in Cuba. Also in Cuba, this wasp is homeomorphic with (or "mimicked" by) the syrphid fly, *Salpingogaster punctifrons* Curran, as observed by me at Banes and by Mr. P. J. Darlington near Soledad.

M. cubensis, typical form

Polybia cubensis H. de Saussure, 1853-1855, Et. Fam. Vesp., II, p. 202, Pl. XXV, figs. 5, 5a and 6 (♀ ♂; Cuba; holotype ♀ and allotype ♂ in Paris Museum); 1856, in de la Sagra, Historia Fis. Pol. Nat. Cuba, Segunda Parte, VII, p. 324; 1857, in de la Sagra, Histoire Phys. Pol. Nat. Cuba, VII, p. 774 (♀). F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 130. Cresson, 1865, Proc. Ent. Soc. Philadelphia, IV, p. 167 (♀ ♂). Gundlach, 1886, Contrib. Entom. Cubana, II, p. 156. Fox, 1890, Ent. News, I, p. 93. Dalla Torre, 1894, Cat. Hym., IX, p. 163. Ashmead, 1894, Psyche, VII, p. 76; 1896, Bull. Labor. Nat. Sci. State Univ. Iowa, IV, No. 1, p. 31; 1900, Trans. Ent. Soc. London, p. 311 (in part). Lewis, 1897, Trans. Amer. Ent. Soc., XXIV, p. 191 (♀). Dalla Torre, 1904, Gen. Insect., Vesp., p. 77.

Megacanthopus cubensis Dueke, 1908, Deutsch. Ent. Zeitschr., p. 698 (♂). Meade-Waldo, 1911, Ann. Mag. Nat. Hist., (8) VII, p. 111.

Polybia phthisica Cresson, 1865, Proc. Ent. Soc. Philadelphia, IV, p. 167 (♀ ♂). Gundlach, 1886, Contrib. Entom. Cubana, II, p. 155. Not *Vespa phthisica* Fabricius, 1793.

Specimens Examined.—GEORGIA: Billy's Island, Okefenokee Swamp; St. Simon's Island (J. C. Bradley.—Cornell Univ.).—FLORIDA: Gainesville, Alachua Co.; Silver Springs, Marion Co. (Geo. P. Engelhardt); Orlando, Orange Co. (A. L. Melander); Kissimmee, Osceola Co. (A.M.N.H.); Tampa, Hillsborough Co. (E. L. Bell); Naples, Collier Co. (G. B. Fairchild); Ft. Lauderdale, Broward Co. (D. M. Bates); Miami, Dade Co. (E. L. Bell); Key Largo; Metacumbe Key; Key West (G. N. Collins and C. L. Pollard.—A.M.N.H.).—BAHAMAS: without more definite locality (Acad. Phila.); Nassau, New Providence (A.M.N.H.). Ashmead records *cubensis* from Eleuthera.—CUBA: without more definite locality (Acad. Phila.); San Carlos Est., Guantánamo (A.M.N.H.); Estación Central Agronómica de Cuba (Acuña.—U.S.N.M.); Mina Carlota, Trinidad Mts., one male, March 20, 1905 (George Salt); San José, Trinidad Mts., August 1930 (R. P. Dow); Camagüey (J.

Acuña); Santiago de las Vegas; Taco-Taco (S. B. Bruner and O. H. Ballou); Tacajo near Banes, Oriente (J. Bequaert); Baragua, Camagüey, June 20, 1932, with nest (G. B. Fairchild and D. M. Bates); "Las Ánimas," 500 m., Sierra de Rángel, Santa Cruz de los Pinos, Prov. Pinar del Río (C. G. Aguayo); Isle of Pines.

I have seen a few specimens of *M. cubensis*, at the Imperial Institute of Entomology (London) and at the Laboratory of Entomology of the Dept. of Agriculture of Jamaica, labelled "Hope Gardens, Jamaica." This record, however, appears questionable, since no other entomologist has ever taken this wasp in the island.

Queen and Worker.—Reddish brown (Ridgway's auburn to chestnut), with the following parts yellow (Ridgway's light cadmium): clypeus (except the narrow, dark-brown margin); a broad band bordering the inner orbits, touching the antennal socket, filling the ocular sinuses, and extending from the clypeus to the vertex, where the two lines converge so as nearly to meet in the middle line; a very broad band on the cheeks margining the outer orbits from the base of the mandibles to the vertex, but not quite meeting the inner orbital band; two large spots above and between the insertions of the antennae, not quite meeting in the middle; a small spot just below the insertion of each antenna; sometimes a single spot just below the median ocellus; mandibles, except their teeth; anterior and posterior margins of the pronotum; two longitudinal lines on the mesonotum (sometimes obsolete or completely absent); a large spot under the insertion of the wings and another on the mesepisternum above the coxa; narrow anterior margins of scutellum and postscutellum and several dots at their lateral extremities near the base of the posterior wings; two or four longitudinal lines on the posterior half of the propodeum; apical margins of some or all abdominal segments to varying widths and either continuous on the sternites or not; most of the tarsi, tibiae, and tips of the femora, together with spots on the coxae. Thorax darker reddish brown than the abdomen, the pleura being very dark or almost black in some specimens. Basal half of the petiole much darker than the apical portion, and the coxae, trochanters, and most of the femora very dark brown. Antennae ferruginous throughout in some specimens, in others darker in the middle above and almost yellowish at the tip. Wings more or less tinged with amber yellow, especially along the anterior margin, basally hyaline, apically smoky; median and radial cells darker. The clypeus of some specimens bears in the middle a line of light red, which sometimes is much broader and this color may even cover the entire clypeus.

Male.—Coloration similar to that of the female and likewise somewhat variable.

M. cubensis var. *mexicanus* (H. de Saussure)

Polybia mexicana H. de Saussure, 1853–1855, Et. Fam. Vesp., II, p. 203, Pl. XXVI, figs. 6 and 6a (♀; Mexico; type in Paris Museum). F. Smith, 1857, Cat. Hym. Brit. Mus., V, p. 130. Dalla Torre, 1894, Cat. Hym., IX, p. 164; 1904, Gen. Insect., Vesp., p. 78. W. A. Schulz, 1905, Hymenopteren-Studien, p. 132 (♀).

Specimens Examined.—MEXICO: several females, workers and males without more definite locality (Acad. Phila.).—GUATEMALA: Palinque, one female (H. W. Atkinson).—REPUBLIC OF HONDURAS: Tegucigalpa, one worker (F. J. Dyer); Puerto Castilla, one female; Prieta, one male (J. Bequaert).

W. A. Schulz (1905) records *P. mexicana* from Popayán, Colombia. This identification is open to doubt, since I have seen a somewhat similar, but apparently distinct species from Panamá. He claims that Fox's specimens of "*mexicana*" from Rio de Janeiro, Brazil, (1898, Proc. Acad. Nat. Sci. Phila., p. 451) could not have been that species. Most probably they were *M. alfkenii* Ducke, which, as I have pointed out above, is perhaps not distinct from *M. cubensis* var. *mexicanus*. Ashmead's *Polybia mexicana* (1900, Trans. Ent. Soc. London, p. 311), from Porto Rico, refers to *Mischocyttarus phthisicus* (Fabricius), the only Polybiine wasp known from that island.

Polybia mexicana R. v. Ihering (1904, Rev. Mus. Paulista, VI, pp. 186 and 251), from southern Brazil, was *Polybia oecodoma* H. de Saussure, as recognized by Ducke.

The color characters separating this Central American form from typical *cubensis* have been indicated in the key. The pattern and main tinge of the abdomen vary from pale brownish or orange red, with few yellow markings, to russet or blackish brown, with conspicuous yellow bands. In the males, the russet color of the body is almost entirely replaced by black. In all specimens seen, of both sexes, the mesonotum is brownish black or black with two curved longitudinal yellow stripes, which do not reach the front and hind margins. The var. *mexicanus* averages slightly larger than the typical form of the species.

ACKNOWLEDGMENTS

I have studied specimens of North American Polybiinae belonging to the following public collections: American Entomological

Society (at the Academy of Natural Sciences, Philadelphia, through Mr. E. T. Cresson, Jr.); American Museum of Natural History, New York (through Dr. F. E. Lutz and Mr. H. F. Schwarz); Brigham Young University, Provo, Utah (through Prof. V. M. Tanner and Mr. C. L. Hayward); California Academy of Sciences, San Francisco (through Dr. E. P. Van Duzee); Department of Agriculture of Canada, Entomological Branch (through Mr. G. S. Walley); Entomological Department of Cornell University, Ithaca, N. Y. (through Prof. J. C. Bradley); Museum of Comparative Zoölogy, Cambridge, Mass. (through Mr. N. Banks); Oregon Agricultural Experiment Station, Corvallis, Oregon (through Prof. H. A. Scullen); and United States National Museum (through Miss Grace Sandhouse); of private collectors I am particularly indebted to Mr. D. M. Bates, Mr. Richard Dow, Mr. G. B. Fairchild, Mr. Max H. Ruhmann, Professor G. J. Spencer, Mr. C. Lynn Hayward, Dr. George Salt, and Mr. H. F. Schwarz.³² I am also under obligation to Mr. H. F. Schwarz and Miss Grace Sandhouse for much help and valuable suggestions. The photographs of the nests of *Nectarina lecheguana* and *Mischocyttarus flavitarsis* var. *navajo* I owe to the courtesy of the American Museum of Natural History (through Dr. F. E. Lutz and Mr. H. F. Schwarz); while those of *M. flavitarsis* (typical) and *M. cubensis* were made by Mr. D. W. Farquhar.

³² Since the MS was sent to the printer, a large collection of *Mischocyttarus* was sent for study by the Department of Entomology, University of Kansas (through Mr. J. M. Brennan).

PLATE XXVII

Side view of nest of *Nectarina lecheguana* (Latreille), taken at Brownsville, Texas, by Mr. Herbert F. Schwarz and Dr. F. E. Lutz. A 20 cm. scale placed along the basal end. Courtesy of American Museum of Natural History, New York.

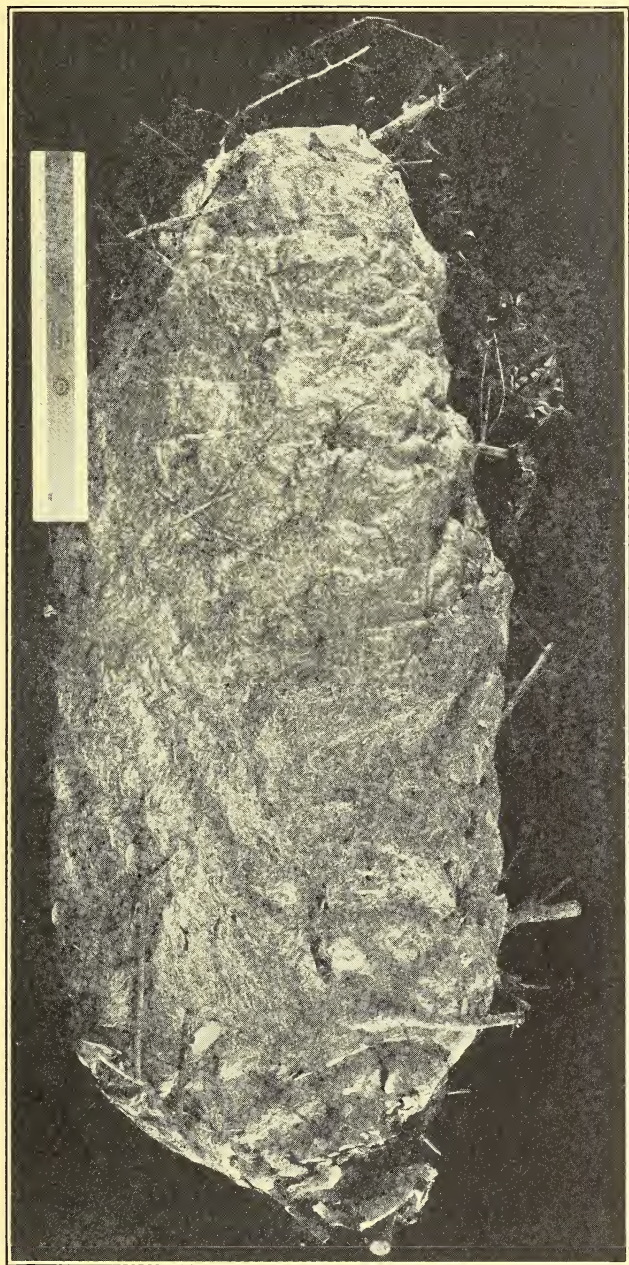


PLATE XXVIII

Apex of the same nest of *Nectarina lecheguana* (Latreille), shown in Plate XXVII. Courtesy of American Museum of Natural History, New York.

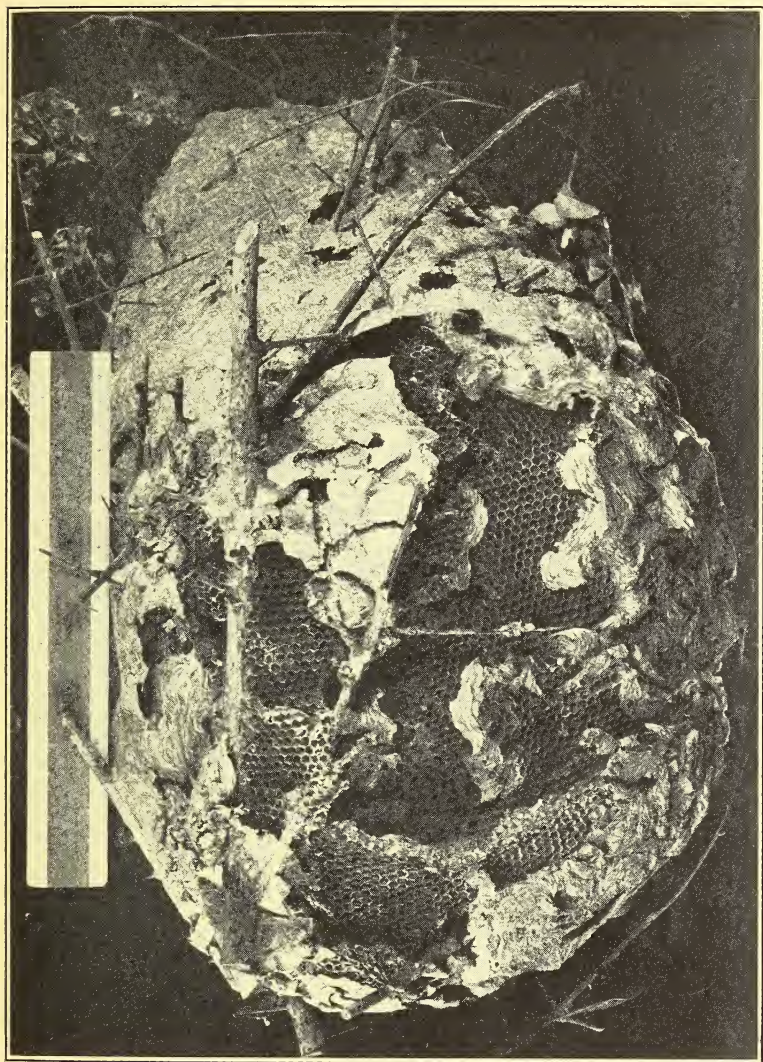
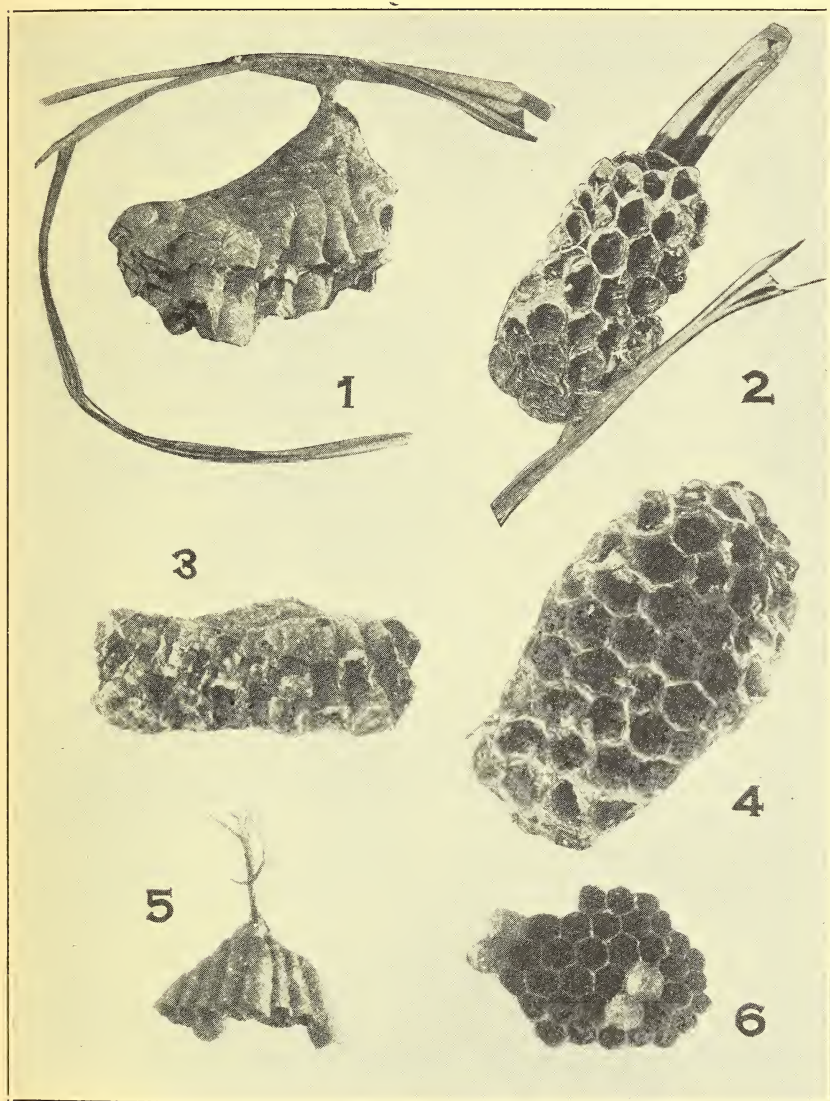


PLATE XXIX

Figs. 1 and 2. Nest of *Mischocyttarus flavitarsis* var. *navajo* J. Bequaert, taken by Dr. F. E. Lutz in the Santa Catalina Mts., Arizona; from the side and below. Natural size. Courtesy of American Museum of Natural History, New York.

Figs. 3 and 4. Nest of *Mischocyttarus flavitarsis* (H. de Saussure), typical form, taken by Prof. H. A. Scullen near Corvallis, Oregon; from the side and below. Natural size. Photographs by D. W. Farquhar.

Figs. 5 and 6. Nest of *Mischocyttarus cubensis* (H. de Saussure), taken by Mr. G. B. Fairchild and Mr. D. M. Bates at Baragua, Cuba; from the side and below. Natural size. Photographs by D. W. Farquhar.



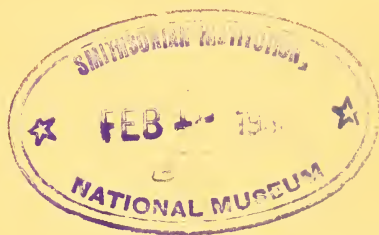
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MICROLEPIDOPTERA OF CUBA

BY AUGUST BUSCK

U. S. BUREAU OF ENTOMOLOGY, WASHINGTON, D. C.

During the last few years considerable careful rearing of Microlepidoptera has been done by the "Departamento de Entomología" of the "Estación Experimental Agronómica" at Santiago de las Vegas, Cuba.

This rearing has been done partly by my friend, the able chief of the Department, Dr. S. C. Bruner, but more especially at his direction by Mr. Angel R. Otero, who is particularly successful in collecting and caring for larval material and in rearing it to the adult stage in perfect specimens.

I am very grateful to both of these gentlemen for placing in my hands this valuable material, which much more than doubles our knowledge of the Cuban fauna of Microlepidoptera.

Only a small part of Mr. Otero's reared species have been dealt with in this paper; the balance will be treated in a subsequent installment.

Aside from its great technical interest, it is important to make this knowledge available in printed form because the collection embraces several actual and potential economically injurious species, which, owing to Cuba's proximity to the United States, may easily become introduced here.

In this paper is also included such other Cuban material as has accumulated in U. S. National Museum from other sources, notably species reared and collected for the "Estación Experimental," Central Baraguá, by Mr. L. C. Scaramuzza and Mr. H. K. Plank,

the latter of whom was so kind as to do some light collecting at my suggestion. Most of the earlier Cuban material available was collected by Dr. Wm. Schaus and by the writer.

Two new genera and twenty-five new species are described in this paper, and fifteen genera and species are recorded for the first time from Cuba. The food-plant records of a large number of these species are of particular value.

The writer is under obligation to Mrs. Eleanor A. Carlin, of the U. S. Bureau of Entomology, for her careful drawings made under his direction from slides prepared by him.

All types and cotypes are deposited in the U. S. National Museum; a duplicate set of the same rearings is in the Agricultural Station's collection in Santiago de las Vegas.

Mr. Otero will give more detailed notes on the early stages of the reared species in a separate paper.

FAMILY PTEROPHORIDAE

Exelastis pumilio Zeller

Mimeseoptilus pumilio Zeller, Verh. Zool. bot. Gesell. Wien., vol. 23, p. 324, 1873.

Mimaeseoptilus gilvidorsis (not Zeller) Hedemann, Stett. Ent. Zeitg., vol. 57, p. 8, 1896.

Stenoptilia? *pumilio* Walsingham, Proc. Zool. Soc. London, p. 58, 1897; Meyrick, Gen. Insect. Fasc. 100, p. 18, 1910.

Marasmarcha liophanes Meyrick, Trans. Ent. Soc. London, p. 19, 1886; Gen. Insect. Fasc. 100, p. 18, 1910.

Marasmarcha pumilio Barnes and Lindsey, Contr. Nat. Hist. Lep., vol. 4, p. 348, pl. 13, fig. 7, 1921; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 78, 1930.

Exelastis pumilio Fletcher, Cat. Ind. Ins., part 20, p. 38, 1931.

This cosmopolitan tropical species was reared by Dr. Bruner from larvae feeding on *Meibomia* at Santiago de las Vegas, Cuba. (Otero No. 9455.)

FAMILY TORTRICIDAE

Amorbia phaseolana Busek

Amorbia phaseolana Busek, Bruner, Informe Dept. Entomology Santiago de las Vegas, Cuba, p. 23, 1931.

This species was described from two males reared from Lima bean, to which crop it had become a pest of some economic importance. Since then I have received a good series of both sexes from

Mr. Otero reared from leaf-tying larvae on *Psidium* (Guava) and *Althaea* (Otero, No. 9524), proving the species as indiscriminate in its choice of foodplants, as are the other species of the genus. The females, as predicted, are considerably larger than the males, measuring 25 mm. in alar expanse. Genitalia of both sexes (pl. XXX, fig. 4, and pl. XXXVI, fig. 8) are typical of the genus.

Apotoforma new genus

Genotype. — *Oxygrapha rotundipennis* Walsingham (West Indies).

Antennae of male, half the length of the forewings, shortly ciliate on the underside, thickened with scales, and with a circle of erect scales on each joint. Labial palpi short porrect, second joint thickened with protruding rough scales towards apex, terminal joint short. Face smooth, clothed with very short scales, head with rough scaling; thorax smooth. Forewings with raised scales, without costal fold in the male, elliptical; costa and dorsum gently and evenly rounded and meeting in the longitudinal center of the wing in an undefined evenly rounded apex; 12 veins; vein 6 to the tip of the wing or a little above it; 7 to costa; 8, 9, 10, and 11 well separated, nearly equidistant; 5 straight; 3 and 4 long-stalked; 2 from middle of cell; *lc* present in its entire length. Hindwings as broad as forewings, trapezoidal; costa and dorsum straight, parallel, termen nearly straight, apex bluntly pointed; 7 veins; 3 and 4 united; 5 approximate; 6 and 7 closely approximate throughout basal third of their length, enclosing apex. (Pl. XXX, figs. 2 and 3.)

Male genitalia with uncus and socii absent; gnathos flattened in center and with a narrow ventral plate along underside of the alimentary canal to the tip of the tegumen; transstilla a narrow curved band; harpes nearly divided, with a strongly chitinized broad bifurcate sacculus and a longer flimsy pointed costal part; aedoeagus short, truncate, bilobed at apex; cornuti six equal rather long and slightly curved spines. (Pl. XXX, fig. 1.)

Female genitalia with base of ovipositor lobes thickened, upturned; ductus short, looped just before bursa; bursa elongate oval, without signum. (Pl. XXXVI, fig. 9.)

This remarkable genus is clearly a development from *Peronea* and has its counterpart in the Indian genus *Paratorna* Meyrick, which has an even more extravagant development of the forewings, with costa further deflected, so as to bring vein 5 to apex. The present genus differs also from *Paratorna* in having only 7 veins in

the hindwings, with 3 and 4 united, not stalked: the male genitalia substantiate the common origin from *Peronea*.

The related genus *Eboda* Walker in which Meyrick has placed the genotype, *rotundipennis*, agrees with the present genus in venation, but it has a very different wing form and possesses curiously developed socii.

Apotoforma rotundipennis Walsingham

Oxygrapha rotundipennis Walsingham, Proc. Zool. Soc. London, p. 132, 1897.

Eboda rotundipennis Meyrick, Gen. Ins. Fasc. 149, p. 59, 1913.

Paratorna rotundipennis Forbes, Sci. Surv. Porto Rico, vol. 12, p. 83, 1930.

Labial palpi ochreous white, touched with brown, terminal joint brown. Antennae dark golden fuscous. Lower half of face ochreous white; upper half and head dark brown. Thorax light ochreous brown. Forewings light ochreous brown; costal edge reddish brown; just before the middle of costa a broad outwardly oblique costal streak, diffused outwardly; at apical fifth another dark brown, outwardly curved streak, parallel and close to the apical edge and reaching below the tip of the wing. At basal third two obliquely placed small tufts of raised black scales; two similar but smaller tufts on fold, and two at the end of the cell; cilia light ochreous brown. Hindwings light ochreous fuscous with ochreous cilia; abdomen fuscous. Legs ochreous, broadly barred with dark fuscous.

In the U. S. National Museum are specimens from Havana, Cuba, C. F. Baker coll., and also reared series from *Acacia*, Ft. Prince, Florida (E. W. Berger), and Gainesville, Florida (T. L. Cain).

Alar expanse.—10–11 mm.

Type.—British Museum.

Type locality.—St. Thomas, West Indies.

Foodplant.—*Acacia arabica*.

Ancylys cordiae new species

Second joint of labial palpi with strong tuft, concealing terminal joint; white at base, light brown at apex, with a small black spot on outer side. Face light ochreous. Head light ochreous brown. Antennae light brown with a black dot on underside of second joint. Thorax light brown. Forewings with strongly produced falcate apex, termen

sharply sinuate below; light whitish brown with a large triangular dark brown spot resting on dorsal edge from base to apical fourth; base of costa dark brown with a violet sheen; costal edge darker brown with a series of nearly equidistant silvery geminate streaklets; three equidistant small black dots in a row on basal third; dorsal half of apical part of wing mottled with black scales; apex brown edged with white; cilia light brown. Hindwings light fuscous with a violet sheen. Abdomen dark fuscous above with silvery underside and ochreous genital tuft. Legs strongly tufted, light ochreous with dark brown tarsal annulations.

Male genitalia (pl. XXX, fig. 6) without defined uncus; socii large, pendant; cucullus triangular, heavily spined on outer edge and with a single stronger spine on basal corner; aedoeagus long, straight, sharply pointed; cornuti a large bunch of many long slender spines.

Alar expanse.—13 mm.

Type.—U. S. National Museum Cat. No. 44132.

Type locality.—Santiago de las Vegas, Cuba.

Foodplants.—*Cordia globosa* and *Gouania polygama* (Otero No. 9721, leaf-tyer).

Ancylis bauhiniæ new species.

Labial palpi smooth, blackish brown, base and inner sides ochreous. Lower face smooth, silvery white. Head blackish brown. Antennae with basal fifth and outer half blackish brown, separated by a wide cream-white band, last joint white. Anterior third of thorax and shoulder-flaps blackish brown, rest of thorax ochreous white. Forewings ochreous white; outer half yellowish, mottled with metallic leaden scales; a large, semicircular, blackish brown dorsal spot from basal fifth to beyond middle of dorsum and reaching two-thirds the width of the wing; extreme base of costa blackish brown; outer two-thirds of costa narrowly light reddish-brown with alternating oblique white and metallic leaden streaklets; below this a longitudinal whitish streak, finely irrorated with transverse black streaklets; this streak is continued into a perpendicular white patch with black transverse lines; beyond this apical edge is light reddish-brown with a short silvery streak on the middle of termen before the light ochreous brown cilia. Hindwings dark fuscous with lighter cilia. Abdomen dark fuscous, with underside slightly lighter. Anterior legs blackish brown; posterior legs smooth silvery fuscous; tarsi with narrow ochreous annulations. The male genitalia (pl. XXX, fig. 7) with short, pointed, hairy

uncus, well developed pending socii, evenly rounded cucullus, aedoeagus long, nearly straight, cornuti a bunch of (7-8) long slender spines.

Alar expanse.—9-11 mm.

Type.—U. S. National Museum Cat. No. 44133.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Bauhinia heterophylla*. (Otero No. 9719.)

This very striking species is somewhat divergent in the genus because of its smooth palpi and legs and the close proximity at base of veins 7 and 8 in forewings, but other characters and the pattern and general habitus are clearly those of *Ancylis*.

Strepsicrates smithiana Walsingham

Strepsicrates smithiana Walsingham, Proc. Zool. Soc. London, p. 506, 1891; idem, p. 127, 1897; Wolcott, Journ. Dept. Agr. Porto Rico, vol. 8, p. 202, 1917; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 91, 1931.

Reared by Mr. Otero (No. 9468) from Guava, *Psidium guajava*, at Santiago de las Vegas, Cuba.

Gymnandrosoma pithecolobiae new species

Labial palpi black, slightly sprinkled with white scales on basal two-thirds of second joint and with extreme tip of terminal joint white. Maxillary palpi minute, white. Face black, in the male with lower third pure white; in the female sparsely sprinkled with white. Head dark brown.

Antennae less than half of wing length, stout, simple in the female, in the male ciliate and with basal sixth to sixteenth joints scooped out above to about half their thickness in a shallow notch. Thorax blackish brown with a central transverse band of reddish brown and with posterior tuft white. Forewings dark brown profusely mottled with black, bluish, reddish, and white iridescent scales, extreme costal base black, basal half of wing somewhat darker than apical half, containing more black scales, which tend to form irregular transverse lines; apical half of costa with small, indistinct, geminate ochreous spots; at end of cell a pure white dot; cilia bluish black mixed with brown. Hindwings blackish brown with lighter fuscous cilia; in the male with a large, strongly tufted pouch on base of dorsum, closely covering the posterior tibia when the moth is at rest and containing a long ochreous hair-tuft and a patch of short modified yellow scales. Legs blackish brown, with narrow ochreous annulations, tuft on posterior tibiae yellowish.

Male genitalia (Pl. XXX, fig. 5) very similar to those of the genotype and other species in the genus, but differing from all of them in the much more excavated neck and more pronounced and pointed base of cucullus. Female genitalia nearly identical with those of the other described species, with the same chitinized parts of the ductus, and with signum two strong curved thorns rather more slender than in the other closely allied species.

Alar expanse.—16 mm.

Type.—U. S. National Museum Cat. No. 44134.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Pithecolobium*. (Otero No. 9601, "feeding in the seeds.")

The five described species of this genus are closely allied and very similar in coloration and structure. The present species agrees with *Gymnandrosoma aurantica* Costa Lima, in the notched male antennae, not present in the other three species; Dr. Da Costa Lima was so kind as to send me a male cotype of his species, reared from orange in Brazil; from this species the present may most easily be distinguished by the white thoracic tuft and by the details of the male genitalia. There is, however, another undescribed species of this genus, feeding on Guava in Porto Rico, which also has a white thoracic tuft, and which presumably also will be found to occur in Cuba.

FAMILY MOMPHIDAE

Stilbosis lonchocarpella new species

Labial palpi yellowish white, so strongly mottled with black scales as to appear dark. Face silvery. Head blackish brown. Thorax blackish brown with silvery posterior tip. Forewings light ochreous, mottled with shining blackish brown; extreme base blackish brown; beyond this, basal half of wing unmottled ochreous, except for a tuft of erect brown scales at basal fourth and the costal edge, which is strongly suffused with dark brown; this basal area is edged by two tufts of erect scales, the upper and slightly preceding ochreous, the lower and larger blackish brown; beyond these is an ill-defined broad transverse fascia, heavily overlaid with blackish brown and edged exteriorly by two tufts of erect blackish brown scales tipped with ochreous; a small less mottled ochreous area intervenes before the apical fifth of the wing, which is mixed black brown, with a metallic sheen; cilia dark fuscous. Hindwings and cilia lighter fuscous.

Abdomen shiny dark fuscous with light ochreous underside. Legs blackish brown with narrow white annulations.

Male and female genitalia typical of the genus, at once placing the species with the North American genotype, *S. tesquella* Clemens.

Alar expanse.—8–10 mm.

Type.—U. S. National Museum Cat. No. 44135.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Lonchocarpus sericeus*. (Otero No. 9712.)

The larvae are leaf-tyers and very similar to those of *S. tesquella*, white with tubercles small jet black dots.

FAMILY GELECHIIDAE

Nealyda pisoniae Busck

Nealyda pisoniae Busck, Proc. U. S. Nat. Mus., vol. 23, p. 229, pl. 1, fig. 5, 1900; Dyar, Proc. Ent. Soc. Wash., vol. 4, p. 470, 1901; List N. Amer. Lepid., No. 5569, 1903; Barnes and McDunnough, List Lepid. Bo. Amer., No. 6091, 1917.

This interesting species, described from Palm Beach, Florida, and not hitherto recorded outside the type locality, was reared both by Mr. Otero (No. 9592) and by Mr. L. C. Scaramuzza (No. 3913) from *Pisonea aculeata*.

The larva makes large irregular blotch mines on the upper surface of the leaf; when mature it cuts its way out and spins a tough, oval, flat, white cocoon near by.

The genitalia of both sexes are typical of the genus. The male genitalia of the genotype, *Nealyda bifidella* Dietz, drawn by Mr. Harry Bradford of the U. S. Bureau of Entomology, are given (Pl. XXXI, figs. 1 and 2). The present species differs from it in having the aedoeagus longer and slenderer, the lower arm of the harp reduced to a strong curved spine, and the upper arm of the harp with a stout spine on inner side. The female genitalia of the present species have the ductus bursae longer and the signum much longer than in the genotype.

Tholerostola evippella Forbes

Tholerostola evippella Forbes, Journ. Dept. Agr. Porto Rico, vol. 15, p. 364, 1931.

Described from collected specimens in Porto Rico. Mr. Otero has reared a large series of this species from leaves of *Aeschynomene americana* at Santiago de las Vegas, Cuba. (Otero No. 9407.) The

genus differs in venation from *Evippe* Chambers only in having vein 6 of forewing separate from 7 and 8.

***Aristotelia eupatoriella* new species**

Labial palpi very long and slender, terminal joint longer than second, light ochreous, second joint with three incomplete broad dark brown annulations, terminal joint with four such annulations. Antennae blackish brown with first joint ochreous and with two longitudinal ochreous lines, consisting of single scales, two on each joint. Face light ochreous. Head and thorax light brown, mottled with black scales. Forewings with costal half light ochreous, heavily powdered with black and with black markings; near base a broad black fascia reaching to the fold, edged outwardly by a nearly unmottled, outwardly oblique, ochreous fascia reaching faintly to the dorsal edge; this is followed on basal third by a black fascia reaching to the fold and continued outwards on the cell; at apical third a predominantly black area, containing a small unmottled, ochreous costal dash and followed by a larger conspicuous light ochreous costal dash, also present on the otherwise dark brown underside of the wing; this light dash is in turn followed by an unmottled blackish brown spot just before the apex; dorsal half of the wing dark brown, sparsely sprinkled with dark scales, crossed at basal third by the light ochreous fascia and edged towards the second black costal fascia by a light ochreous longitudinal line; on the underside of the forewings in the male, near base of costa, a strong tuft of long yellow hairs and another more basally of short black hairs. Hindwings light ochreous with base and two longitudinal broad lines of deep black scaling reaching from near base nearly to termen, the upper one broader and longer than the lower and separated from it by a thin line of the ground color (Pl. 2, fig. 8); the basal patch is repeated on the underside of the wing, the basal half of which is clothed by semierect velvety scaling. Abdomen light ochreous with the three first joints velvety black above. Legs yellowish with broad black bars; tarsi black with narrow ochreous annulations. The females have no costal hair pencil at base of forewing, the hindwings are dark fuscous above with ochreous underside.

Male and female genitalia typical of the genus (Pl. XXXI, figs. 3, 4, and 6.)

Alar expanse.—10–11 mm.

Type.—U. S. National Museum Cat. No. 44136.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Eupatorium villosum*. (Leaf-tyer, Otero No. 9847.)

The remarkable sex-scaling of the male at once differentiates this species from the several others of this immediate *roseosuffusella* group (*Eucatoptus*).

Anacampsis meibomiella Forbes

Anacampsis (*Compsolechia*) *meibomiella* Forbes, Journ. Dept. Agr. Porto Rico, vol. 15, p. 376, pl. 42, fig. 16, 1931.

Described from Mr. Otero's specimens No. 9454, reared from *Meibomia*, Santiago de las Vegas, Cuba. The figure number in the text is mistakenly given as 17, which represents *Anacampsis melanophala*, a very different insect; it should be fig. 16, as correctly given in the explanation of plate 47.

Polyhymno luteostrigella Chambers

Polyhymno luteostrigella Chambers, Can. Ent., vol. 6, p. 247, 1874; Washington, Trans. Ent. Soc. London, p. 95, pl. 7, fig. 78, 1892; Proc. Zool. Soc. London, p. 77, 1897; Busck, Proc. U. S. Nat. Mus., vol. 25, p. 839, pl. 31, fig. 26, 1903; Meyrick, Gen. Ins., Fasc. 184, p. 105, 1925; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 123, 1930.

Reared by Dr. Bruner from *Cassia chamaechrista* (No. 9423) at Santiago de las Vegas, Cuba. The species feeds on the same foodplant in Eastern and Southern United States.

Gnorimoschema lycopersicella Busck

Phthorimaea lycopersicella Busck. Proc. Hawaiian Ent. Soc., vol. 7, p. 171, pl. 2, 3, 1928; Swezey, idem, p. 177, 1928; Campbell and Elmore, Calif. Mo. Bull., vol. 20, p. 458, 1931.

Gnorimoschema lycopersicella Busck, Proc. Ent. Soc. Wash., vol. 33, p. 60, 1931; Thomas, Journ. Econ. Ent., vol. 25, p. 137, 1932.

Reared by Mr. Otero from larva mining on leaves of eggplant. (No. 9848.) The species, described from the Hawaiian Islands, where it is an introduced species, has been recorded from California, several localities in Mexico, both east and west, and from Pennsylvania. Its original foodplant is wild *Solanum*, but it occasionally becomes of some economic importance by injuring cultivated Solanaceous crops like tomatoes and eggplant.

Prostomens brunneus Busck

Prostomens brunneus Busck, Proc. U. S. Nat. Mus., vol. 25, p. 838, pl. 31, fig. 25, 1903; Meyrick, Gen. Ins., Fasc. 184, p. 140, 1925.

This curious species (Genotype) had not been received since it was described thirty years ago from Florida and it is very gratifying that Mr. Otero has not only re-discovered it in Cuba, but also found its foodplant; the species is a leaf-tyer on Guava, *Psidium guajaba*. (Otero No. 9637.)

Trichotaphe melissia Walsingham

Dichomeris melissia Walsingham, Biol. Cent. Amer., vol. 4, p. 97, 1911.

Cymotricha melissia Meyrick, Gen. Ins., Fasc. 184, p. 189, 1925.

Lecithocera emigrans Meyrick, Exot. Micros., vol. 2, p. 435, 1921.

Brachmia emigrans Meyrick, Gen. Ins., Fasc. 184, p. 249, 1925.

Trichotaphe (Onebala) melissia Forbes, Journ. Dept. Agr. Porto Rico, vol. 15, p. 373, 1931.

A somewhat variable common species with wide distribution in the American tropics. The natural foodplant is *Ipomaea*, from which Mr. Otero reared the species in Cuba (Otero No. 9442) but the species is occasionally injurious to sweet potato. The writer has reared the species from both wild and cultivated plants in Barbados, guided by my late friend, John R. Bovell, at that time Director of Agriculture on the island, who informed me that he had sent the species to Mr. Meyrick and received the name *emigrans*, thus enabling the synonymy. The type series of *D. melissia* in the U. S. National Museum came from Panama (Busck).

We have the species also from Perú, where it is reported an economically important pest of sweet potato.

FAMILY OECOPHORIDAE

Hypercallia bruneri new species

Labial palpi and antennae rose-pink. Face, head, and thorax yellowish brick-red with pink edges. Forewings light brick-red with costal and apical edges rose-pink; a canary yellow round dot on the middle of the cell; another similar one on the end of the cell; a small triangular, yellow costal spot on apical fourth; terminal cilia from just below apex to

just above tornus light canary yellow, dorsal cilia pink. Hindwings and cilia light rose-pink. Abdomen above light reddish brown, underside yellowish. Legs light yellow, tibia rose-pink on the outer side; last tarsal joints pink.

Alar expanse.—18 mm.

Type.—U. S. National Museum Cat. No. 44137.

Type locality.—Baracoa, Cuba; S. C. Bruner, collector.

It gives me pleasure to name this strikingly beautiful species in honor of its collector, my friend Dr. S. C. Bruner, who has added much to the knowledge of Cuban insects.

FAMILY STENOMIDAE

Stenoma comma Busek

Stenoma comma Busek, Proc. U. S. Nat. Mus., vol. 40, p. 218, pl. 8, fig. 11, 1911; Meyrick, Exot. Micros., vol. 1, p. 509, 1916.

Stenoma melancrypta Meyrick, Exot. Micros., vol. 1, p. 455, 1915.

Part of the type series of this species came from Cuba (Schaus coll.). The species is also found in the Guianas, and, according to Dr. Forbes, in Porto Rico. We have the species in both sexes from Sierra Maestro, Cuba, 1,000 feet alt. (O. Querci, coll.), from which the figures of genitalia are drawn. (Pl. XXXI, figs. 5 and 7.)

The male of this pretty species is at once recognized by the black comma-like scaling near the base of the hindwings.

Stenoma ocella Forbes

Mothonica ocella Forbes, Sci. Surv. Porto Rico, vol. 12, p. 130, figs. 3, 8, 1930.

This species is uncomfortably close to *Stenoma fluminata* Meyrick (Trans. Ent. Soc. London, p. 716, 1912), described from Dutch Guiana and subsequently recorded from Brazil and Columbia (Meyrick, Ann. Nat. Mus. Wien, vol. 44, p. 253, 1930); without examination of the genitalia, *occella* Forbes would be considered a synonym of Meyrick's earlier name. The genitalia also are very similar, but *fluminata* has a narrower, longer sacculus projecting beyond the edge of the cucullus, and has the uncus distinctly bifid, while in *occella* the latter is simple and the sacculus is broad and short, not reaching the outer edge of the cucullus. The lower edge of the vinculum in *fluminata* is distinctly and rather deeply bilobed, while in *occella* this edge is very evenly rounded. (Not shown in Forbes's figure.)

Forbes evidently placed his species in *Mothonica* on its general resemblance to the figure of the genotype, *M. periapta* Walsingham (Biol. Cent. Amer., vol. 4, p. 153, pl. 5, fig. 30, 1912).

It does not agree structurally with Walsingham's generic description, which lays stress on the stalked veins 8 and 9 in the forewing and the approximate (not stalked) veins 6 and 7 of the hindwing, while Forbes's species has the former separate and the latter stalked. These venational characters are, however, not dependable in the family *Stenomidae*, where classification will ultimately have to be recast on characters of the genitalia; these are very diversified in the family and enable excellent grouping of the more than one thousand species already described and at present lumped in the genus *Stenoma*. When this is done it is quite possible that the name *Mothonica* may be available for the group with the general type of genitalia represented by the present species, but as the genus was founded on a single female without abdomen, which first must be properly re-identified with corresponding males, and as it is very uncertain that this genotype really belongs to the same group as Meyrick's and Forbes's species, it seems a little "mothonicos" to apply Walsingham's name to species which do not agree with the main characters depended upon by the author of the genus; I prefer to follow Meyrick including them in the present waste-basket, *Stenoma*, until the family is revised.

The figure given by Forbes would indicate that the signum of the female is a single spiny plate, but the species has two such signa, as is the rule in the family, very much as in the figure given here for *Stenoma comma* Busck. In other species of the family the two are commonly connected by a narrow spiny band.

FAMILY ETHMIDAE

Ethmia confusella Walker

Hyponomeuta confusellus Walker, Cat. Lep. Brit. Mus., vol. 28, p. 531, 1863.

Ethmia confusella Walsingham, Proc. Zool. Soc. London, p. 88, 1897; Dyar, Journ. N. Y. Ent. Soc., vol. 10, pp. 202, 205, 1902; Grossbeck, Bull. Amer. Mus. Nat. Hist., vol. 37, p. 143, 1917; Wolcott, Journ. Dept. Agr. Porto Rico, vol. 7, p. 203, 1923; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 134, 1930.

Cryptolechia strigosella Walker, Cat. Lep. Brit. Mus., vol. 29, p. 710, 1860.

Psecadia ingricella Moeschler, Ab. Senck. Nat. Ges., vol. 15, p. 343, fig. 19, 189; Walsingham, Proc. Zool. Soc. London, p. 527, 1892.

Not *Ethmia* (*Psecadia*) *confusella* Rebel, (preocc.) Iris, vol. 13, p. 169, 1900.

Described from Santo Domingo, this common species extends to most of the West Indian Islands; we have series from Cuba (Schaus), Santo Domingo and Calebra (Busck), Porto Rico (Forbes), Jamaica (E. L. Bell), Dominica (Kearfott collection), Grenada (Schaus), and from Key West, Florida. The genitalia are figured (pl. XXXIII, figs. 1 and 1a; pl. XXXVI, fig. 7).

Ethmia cubensis new species

Labial palpi dull white, second joint with three black annulations; terminal joint with two broad black annulations. Antennae dark fuscous, basal joints whitish. Face and head light ochreous fuscous with a small dark brown median tuft on posterior margin of the head. Thorax light ochreous fuscous with ten brown, nearly equidistant, marginal dots. Forewings dull white, strongly suffused with fuscous; costal edge light fuscous; from base of costa an outwardly oblique interrupted and irregular dark fuscous cloud to basal third of cell, followed by a small irregular nearly white area on the middle of the cell; from beyond this area an interrupted, irregular, longitudinal dark brown streak to below apex; shorter longitudinal, ill-defined, brown streaklets above and below the cell and along the veins; ten or eleven dark brown marginal spots from apical fifth of costa to tornus; cilia white, mixed with brown and with dark brown apical pencils. Hindwings hyaline, semitransparent on basal half, darker, fuscous towards apex; cilia white, fuscous towards apex. Abdomen dark fuscous above, with whitish underside and with bright ochreous genital tuft. Legs light ochreous fuscous, front and middle legs barred with dark brown.

Male genitalia (pl. XXXIII, fig. 2) with uncus hood-shaped, gnathos simple; thinly chitinized subscapium supporting underside of anal tube; harps with sacculus strongly curved and tufted, ending in two stout black spines and a cluster of specialized flat scales; cucullus upturned into a triangular piece and a curved, strongly haired apex; sacculus with large, erect, triangular flap posteriorly. Vinculum simple; anellus with two very long, erect, hairy papillae reaching to tip of gnathos; aedoeagus robust, straight, with strongly

curved base and sharp apex; cornuti a single large hook. Female genitalia (Pl. XXXVI, fig. 3) with ductus much longer than the abdomen, spiralled, strongly chitinized towards ostium; signum a four-pointed star covered with minute spines, one diameter with a row of stouter spines.

Alar expanse.—23–26 mm.

Type.—U. S. National Museum Cat. No. 44138.

Type locality.—Sierra Maestra, Camagüey, Cuba (Wm. Schaus, O. Querci, and J. Acuña, collectors), (Otero No. 9862).

Clearly the Cuban representative of the continental *Ethmia baliostola* Walsingham (Biol. Cent. Amer., vol. 4, p. 144, pl. 5, fig. 5, 1912), but considerably smaller and without the pure white apical area found in Walsingham's species; this latter was described a unique type from Costa Rica in the U. S. National Museum. Since then I have collected a good series in Panamá. The genitalia of the Cuban species are also similar to those of *E. baliostola*, but differ in detail, mainly in the form of the cucullus and in possessing two stout spines at the end of saccus, which in Walsingham's species are replaced by additional large scales in the adjoining tuft, and by a large triangular erect flap on the succus, represented in *E. baliostola* by a small stiff bristle.

E. cubensis might also be confused with *Ethmia flavicaudata* Walsingham, which it resembles in pattern and size, but Walsingham's species, described from Mexico and extending to Panamá, has very different genitalia in both sexes.

The present species also occurs in Jamaica, from which we have specimens collected by Dr. Schaus.

***Ethmia oterosella* new species**

Labial palpi dark fuscous on outer side, white on inner side with a fuscous dot on second joint near tip. Face, head, and thorax with light fuscous white-tipped scales. Forewings dirty white with a central longitudinal black streak from base beyond end of cell, somewhat dilated on the cell and edged with pure white scales; base of costal edge black; apical part of wing suffused with light brownish fuscous; cilia white, with a few small black terminal dots. Hindwings whitish fuscous, slightly darker toward apex; cilia white, abdomen light fuscous with whitish underside. Legs white suffused with fuscous.

Female genitalia (Pl. XXXVI, fig. 4) typical, with ductus longer than abdomen, twisted and looped; signum a small erect ridge on a larger less chitinized base.

Alar expanse.—12–15 mm.

Type.—U. S. National Museum Cat. No. 44139.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Stenospermum hamilifolia*. (A leaf-tyer, Otero No. 9632).

It gives me pleasure to name this pretty species after the industrious collector of so many new and reared specimens of Cuban Microlepidoptera, Mr. Ángel R. Otero.

This species is nearest the North American *Ethmia macelhosiella* Busck, but much smaller. The specimens before me are all females.

Ethmia hiramella Busck

Ethmia hiramella Busck, Ins. Inscit. Menst., vol. 2, p. 56, 1914.

This striking Cuban species has not been received since its description, and its foodplant is not known. It is nearest in size, color, and pattern to *E. xanthorrhoea* Zeller from Porto Rico, and is easily mistaken for this species, but differs in details of pattern and in genitalia. (Pl. XXXIII, fig. 3.)

Ethmia subsimilis Walsingham

Ethmia subsimilis Walsingham, Proc. Zool. Soc. London, p. 89, 1897; Meyrick, Lep. Cat., part 19, p. 28, 1914.

This species was described from a unique male from Jamaica. A homotype determined by Walsingham in 1908 from Cuba is in the U. S. National Museum. Mr. Otero has reared the species from larvae on *Trichilia hirta* at Santiago de las Vegas, Cuba (Otero No. 9583). In the National collection are other Cuban specimens collected by O. Querci on Sierra Maestra, 1,000 feet altitude.

The male genitalia (Pl. 5, fig. 2) are very similar to those of the North American *Ethmia deliella* Fernald. (Busck, Contr. Lepid., vol. 4, pl. 36, fig. 10, Decatur, Ill., 1920), with which species, however, it can not be confounded in coloration and markings; uncus broad, rounded; gnathos with top strongly spined; harpes bifurcate at apex, with both lobes sharply pointed; anellus with two long papillae, aedoeagus curved at base, drawn out into a long, attenuated stiff apex. Female genitalia (Pl. XXXVI, fig. 5) with ductus spiralled, longer than the abdomen, strongly chitinized at ostium; bursa large, elongate ovate, with a long, transverse, minutely spined, comb-like signum.

Ethmia submissa Busck

Ethmia submissa Busck, Ins. Inscit. Menst., vol. 2, p. 57, 1914.

This pretty species, described from Cuba, was taken again by Mr. H. K. Plank at Central Baraguá, Cuba, and by Mr. J. Acuña at Camagüey (Otero No. 9861), but the foodplant was not ascertained. The female genitalia (Pl. XXXVI, fig. 2) are typical of the genus, very similar to those of *E. subsimilis* Walsingham (Pl. XXXVI, fig. 5), but the bursa is smaller and the signum larger than in this species, which is easily distinguished by the wing pattern. I have seen no male.

Ethmia clarissa Busck

Ethmia clarissa Busck, Ins. Inscit. Menst., vol. 2, p. 56, 1914.

This species has not been received since its description from Cuba (Schaus coll.) and its foodplant is not known. The male genitalia are given (Pl. XXXIV, fig. 1).

Ethmia abraxasella Walker

Psecadia abraxasella Walker, Cat. Lep. Brit. Mus., vol. 30, p. 1017, 1864.

Ethmia abraxasella Walsingham, Proc. Zool. Soc. London, p. 90, 1897; Meyrick, Lep. Cat., part 19, p. 27, 1914; Wolcott, Journ. Dept. Agr. Porto Rico, vol. 7, p. 203, 1923; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 134, 1930.

Psecadia aureoapicella Moeschler, Abh. Senck. Nat. Ges., vol. 16, p. 341, 1890.

Recorded by Walsingham from Cuba; we have no Cuban specimen, but the species is easily recognized by the yellow dash below the cell. Specimens from Porto Rico are in the U. S. National Museum.

Ethmia nivosella Walker

Tamarrha nivosella Walker, Cat. Lep. Brit. Mus., vol. 29, p. 817, 1864; Walsingham, Proc. Zool. Soc. London, p. 114, 1897; Busck, Proc. U. S. Nat. Mus., vol. 30, p. 728, 1906.

Psecadia adustella Zeller, Horae Soc. Ent. Ross., vol. 13, p. 240, 1877; Moeschler, Abh. Senck. Natur. Ges., vol. 16, p. 343, 1890.

Ethmia nivosella Meyrick, Lep. Cat., p. 19, p. 28, 1914; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 134, 1930.

Ethmia adustella Wolcott, Journ. Dept. Agr. Porto Rico, vol. 7, p. 203, 1923.

This and *E. scythropa* Walsingham have the curious erect scaling on the head (Busck, Proc. U. S. Nat. Mus., vol. 30, p. 729, 1906), which at once separates them from all the other species of the genus with normal smooth head. In the National Museum are specimens of the present species from Cuba (Wm. Schaus) and also from Porto Rico and Jamaica.

The genitalia are given. (Pl. XXXIV, fig. 3; pl. XXXVI, fig. 1.)

Ethmia scythropa Walsingham

Ethmia scythropa Walsingham, Biol. Centr. Amer., vol. 4, p. 148, pl. 5, fig. 13, 1912; Meyrick, Lep. Cat., part 19, p. 28, 1914.

This species, described from a unique type in the U. S. National Museum from Costa Rica, is now well represented in the Museum by a large series from Costa Rica and by two specimens from Cuba (Schaus). It is closest to *E. nivosella* Walker, both in the tufted head and in coloration, but is larger and easily distinguished by pattern and genitalia. (Pl. XXXV, fig. 1.)

***Ethmia ornata* new species**

Psecadia exornata Zeller (in part), Horae Soc. Ent. Ross., vol. 13, p. 239, 1877.

Zeller included and described as a variety of his Peruvian species *Psecadia exornata* two smaller specimens from Cuba, differing in wing form and pattern as well as in size. I had this smaller Cuban species for several years under Zeller's name, and it was so retained by Walsingham, but examination of Zeller's types in Lord Walsingham's collection convinced us both that the Cuban species was not the same as the Peruvian species, and required a new name. As Zeller pointed out, the basal white area of the forewing is not spotted with greenish black, except on costal half, and the dorsal half is pure white; the tornal white area is larger than in *exornata* and the terminal edge is less golden.

The genitalia readily separate the two species. The male genitalia of both are given. (Pl. XXXV, figs. 2 and 3.)

Alar expanse.—19–20 mm.

Type.—U. S. National Museum Cat. No. 44140.

Type locality.—Cuba.

FAMILY ELACHISTIDAE

Donacivola new genusGenotype **Donacivola saccharella** new species

Head smooth, much flattened, face strongly retreating, eyes not visible from above. Labial palpi with second joint very long, porrected, smooth, slightly thickened outwardly, terminal joint erect, half as long as second, slightly thickened, smooth, acute. Maxillary palpi obsolete; tongue well developed, spiralled. Antennae $4/5$, simple, in male shortly ciliated ($1/2$). Thorax broad, flattened, smooth.

Forewings elongate ovate, apex produced, attenuate and upturned; 11 veins, cell open between 9 and 10; 7 and 8 out of 6 to costa; 6 to termen; 4 and 5 out of 6; 9 out of base of 6; 3 absent; 2 strong; 1c present in its entire length; 1b simple. (Pl. XXXII, fig. 5.)

Hindwings (Pl. XXXII, fig. 6) half as broad as forewings, lanceolate, pointed; 5 veins, 4 and 5 absent; cell open; 6 and 7 stalked to termen; 2 and 3 connate. Posterior tibia clothed with long fine but stiff hairs above and below.

Male genitalia (Pl. XXXII, figs. 1 and 2) with uncus absent; socii erect; gnathos ball-shaped, transversely sculptured; anellus with two upright papillae; vinculum with short blunt anterior process; aedoeagus straight.

Female genitalia (Pl. XXXII, fig. 3) with ductus bursa short, funnel-shaped, and chitinized on its outer half; bursa very elongate ovate, granulated on inside, signum a long, narrow, transverse, spiny band.

The genus is a development from *Elachista*, from which it differs in the more complex venation and in the curiously upturned apex of the forewing, as found in the family *Lyonetidae*.

Donacivola saccharella new species

Labial palpi ochreous white, terminal joint with base, apex, and a narrow annulation below apex black. Antennae light gray with faint darker annulations. Face silvery white; head and thorax light gray.

Forewings (Pl. XXXII, fig. 4) light gray, a black spot at base of dorsum, an outwardly, sharply angulated black fascia on the middle of the wing continued into a longitudinal line to apex. Above and below this line and following the fascia a large costal and opposite dorsal white spot at apical third; five converging black streaks in the costal cilia above apex,

separated by white; a round black dot at apex and two black streaks parallel with the edge of the wing in the otherwise white outer part of the dorsal cilia; inner cilia dark fuscous.

Hindwings and cilia dark fuscous. Abdomen dark gray above with silvery underside. Legs silvery gray with broad black annulations.

Alar expanse.—(With tips of wings flattened out) 8–9 mm.

Type.—U. S. National Museum Cat. No. 44141.

Type locality.—Baraguá (L. C. Scaramuzza) and Santiago de las Vegas, Cuba (A. R. Otero).

Foodplant.—Sugar-cane.—(Otero No. 9633.)

The larva has a much elongated, flattened head, with biting mandibles (not a sapsucker). The two halves of the epicranium are greatly prolonged backwards. The edges of the epicranium, the endoskeletal ridges, and the mouth parts are strongly chitinized, dark brown, contrasting with the light yellow color of the rest of the head. Eye spots on front edge of the head capsule deep black. Body flattened and tapering backwards from the very broad first thoracic segment, more than twice the width of the head, which is partly withdrawn in it; a thinly chitinized moon-shaped prothoracic shield. Two pairs of thoracic legs only, those on the first joint obsolete. Abdominal feet on third, fifth, sixth, and ninth abdominal segments, each with a single transverse row of minute crochets.

The larva makes an extensive, elongate, irregular mine on the base of the leaves of sugar-cane. When mature it is about 7–8 mm. long; it leaves the mine and spins a slight dark brown cocoon under which it pupates.

The pupa (Pl. XXXII, figs. 7, 8 and 9) is a most extraordinary exaggeration of the pupa of the genus *Elachista*; the back is flattened or even slightly concave, and the lateral edges are sharply produced and armed with strong, curved, forked spines, one on each abdominal segment. Head and thorax armed with a similar strong but unforked spines; wing covers reaching to eighth abdominal segment; no movable segments. Length 4 mm.

According to reports from the two Cuban experiment stations, this species is a potential economic pest of sugar-cane but is at present kept well in check by abundant affective parasites.

FAMILY GRACILARIIDAE

Porphyrosela desmodiella Clemens

Lithocolletis desmodiella Clemens, Proc. Acad. Nat. Sci. Phila., vol. 11, p. 318, 1859; Walsingham, Proc. Zool. Soc.

London, p. 146, 1897; Meyrick, Gen. Ins., Fasc. 128, p. 11, 1912; Braun, Cornell Mem., vol. 68, p. 193, 1924; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 140, 1930.

Porphyrosella desmodiella Braun, Trans. Amer. Ent. Soc., vol. 34, pl. 24, figs. 14-15, 1908.

A series by Mr. Grove (No. 9621) at Santiago de las Vegas, Cuba, from leaf-mining larvae in *Bradburya* species can not be distinguished from our common *Desmodium* miner of the eastern part of the United States.

Miss Braun's genus *Porphyrosella* has been abandoned by herself and by Meyrick, I think, unwarrantedly; the wing form and venation, as well as larval characters, amply differentiate it.

Phyllonorycter stigmaphyllae new species

Labial palpi and face golden white. Tuft on head reddish brown. Antennae dark fuscous, nearly black above, with narrow light ochreous annulations, underside golden white. Thorax light reddish brown; underside silvery white. Forewings reddish brown with two white transverse fasciae and three white apical dashes; the first fascia from basal fourth of costa slightly inwardly oblique, narrowly margined basally by slightly darker blackish brown scales, outwardly gradually fading into the ground color; second fascia on the middle of the wing straight, similarly edged basally and similarly fading into the ground color posteriorly; a golden white streak at tornus, an opposite golden white dash on costa, and an oblique golden white streak before apex; apical cilia concolorous with wing, dorsal cilia silvery white. Hindwings and cilia silvery white with apex touched by dark fuscous. Abdomen dark fuscous above with silvery white underside and anal tuft. Legs with tibiae brown, tarsi silvery white with blackish brown annulations.

Alar expanse.—5-6 mm.

Type.—U. S. National Museum Cat. No. 44142.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Stigmaphyllon sagralanum* (Otero No. 9590).

An interesting aberrant form, placed in *Phyllonorycter* solely on characters of the imago, which in all respects agree with the genus; venation and legs typical and the white wing-markings dark margined basally. On the other hand the larva and the mine are curiously similar to those of the genus *Cameraria* and on the first inspection of the mine and larva I unhesitatingly placed the species in this genus.

The larva is flattened, with thoracic segments enlarged, twice as wide as head and with a large, oval, chitinized, blackish dorsal spot on each segment as in *Cameraria*; the head is flattened, triangular, with mouthparts protruding in front, yet differing in details from *Cameraria*.

The larvae make large irregular blotch-mines on the upper surface of the leaves, leaving the very thin upper epidermis semitransparent whitish, while the underside of the leaf shows no sign of the mine; the jet black frass is scattered in the mine, but when mature the larva gathers some of it into a ring and uses it as the lateral edges of its nearly circular cocoon, spun above it, in which it pupates.

Spanioptila spinosum Walsingham

Spanioptila spinosum Walsingham, Proc. Zool. Soc. London, p. 148, 1897; Meyrick, Gen. Ins., Fasc. 128, p. 12, 1912; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 141, 1930; Journ. Dept. Agr. Porto Rico, p. 380, 1931.

This curious spiny species has hitherto been known only from a few collected specimens from St. Thomas and Porto Rico. Mr. Otero has succeeded in discovering its larva and foodplant and has reared it to maturity at Santiago de las Vegas, Cuba. The species is a leaf-miner on *Casearia hirsuta* (Otero No. 9623).

Chilocampyla psidiella new species

Antennae pearly white without annulations; flap of scales on basal joint black on outer third. Face pearly white. Head and thorax ivory white. Labial palpi with second joint light yellow sprinkled with black scales and with broad black outer edge; terminal joint pearly white with a narrow black annulation near base; maxillary palpi yellowish, strongly shaded with black. Tongue very long, spiralled at tip.

Forewings light yellow, sparsely sprinkled with black and with indistinct and ill-defined white markings; at basal fourth an indistinct and incomplete transverse whitish fascia, most noticeable by its edging of black scales; before the middle of costa is a similar faint whitish fascia edged with black and running obliquely to the middle of dorsum; beyond this are four other outwardly oblique, faint, white streaks across the wing; between the first two of these is a longitudinal blackish streak above the middle of the wing, and along dorsal edge are scattered slightly raised, black-tipped scales overlapping the edge.

Hindwings dark fuscous with lighter cilia. Abdomen dark fuscous above with silvery white underside. Legs silvery ochreous; front and middle legs with the thickened ends of the tibiae black; tarsi with black annulations; posterior tibiae with two rows of even bristles above.

Male genitalia. Harpes with sacculus straight, parallel; outer costal angle rather sharp, cucullus evenly rounded; anellus with two long curved arms lying along inner surface of harpes; aedoeagus long, nearly straight; cornutus a single very stout curved spine.

Female genitalia with signum consisting of two long, stout, feathery spines connected toward anus by a horseshoe-shaped chitinization.

Alar expanse.—7–9 mm.

Type.—U. S. National Museum Cat. No. 44143.

Type locality.—Santiago de las Vegas, Cuba. (A. R. Otero.)

Foodplants.—*Psidium guajaba* and *Eugenia axillaris*. (Otero Nos. 9713 and 9471.)

The species agrees with the type of the genus in general color and structure, but lacks the costal depression of the forewing of the male of the genotype, *C. dyariella* Busck, which apparently is merely a specific character. The genitalia easily separate the two species in both sexes.

The larva is a typical Gracilariid; when mature, it is 6 to 7 mm. long and turns a deep wine red before spinning its cocoon. The mine on the upper side of the leaf begins as a narrow serpentine track, which broadens out into a large irregular blotch mine; the upper epidermis turns white and makes the mines very noticeable at a distance.

Acrocercops sanctaerucis Walsingham

Dialectia sanctaerucis Walsingham, Proc. Zool. Soc. London, p. 151, 1897.

Acrocercops sanctaerucis Meyrick, Lep. Cat., 6, p. 45, 1912; Gen. Ins., Fasc. 128, p. 16, 1912; Cotton, Journ. Dept. Agr. Porto Rico, 2, p. 300, 1918; Wolcott, idem, 7, p. 205, 1923; Forbes, N. Y. Acad. Sci. Surv. Porto Rico, vol. 12, p. 141, 1930; Journ. Dept. Agr. Porto Rico, p. 380, 1931.

This pretty little species was described from St. Thomas; it was reared by Mr. Otero from blotch mines on *Solanum torvum* (No. 8146). I have reared it from the same plant on St. Croix and in Santo Domingo and have identified it from Porto Rico, reared from eggplant.

Acrocercops undifraga Meyrick

Acrocercops undifraga Meyrick, Exot. Micros., vol. 4, p. 47, 1931; Forbes, Journ. Dept. Agr. Porto Rico, p. 380, 1931.

Described from Haiti, where it was bred from *Solanum torvum*. Mr. Otero reared the series (No. 9491) before me from *Solanum antillarum* in January, while the closely similar *A. sanctaecrucis* has been reared by him and others from *Solanum torvum* (as well as from eggplant); the two species apparently feed indiscriminately on both plants. They are quite distinct both in genitalia and in pattern in spite of their similarity. In *A. sanctaecrucis* the first white, black-edged dorsal spot is more triangular and reaches across the wing to costa and the second nearly so, while in *A. undifraga* these spots are more rounded and do not reach the costa. I regret that I caused Dr. Forbes to consider this species synonymous with *A. sanctaecrucis* before sufficient study of the descriptions.

Acrocercops cordiella new species

Antennae somewhat longer than forewing, whitish fuscous, with indistinct darker fuscous annulations; basal joint with small blackish flap of scales. Second joint of labial palpi white with blackish fuscous outer side; terminal joint pure white with an incomplete fuscous annulation close to the base. Head white. Thorax brown with a longitudinal white streak covering all but the sides.

Forewings light brown with extensive white markings; entire dorsal edge white; a large triangular dorsal spot on basal third reaching costal edge; a second, more rounded, dorsal white spot not quite reaching costa; a third, more flattened, dorsal white spot reaching into the cilia; all of these white markings are edged above with black scales; above the last of the dorsal spots is a slender curved costal white streak also edged with black scales; cilia golden brown except for the white tuft from the apical dorsal spot.

Hindwings dark fuscous with lighter cilia. Under side of body silvery white, abdomen dark brown above. Front and middle tibiae smooth, not thickened, white with broad blackish brown annulations; posterior tibiae and spurs silvery white with a double row of stiff bristles above, tarsi yellowish.

Alar expanse.—6–7 mm.

Type.—U. S. National Museum Cat. No. 44144.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Cordia alba*. (A. R. Otero No. 9477.)

The species is exceedingly similar in pattern and color to *Acrocercops sanctaecrucis* Walsingham and careful discrimination is necessary to separate flown specimens not reared. Perfect specimens, however, can be distinguished by the different details of ornamentation, and the genitalia, although also closely similar, readily prove the two species distinct, as could be expected from the different foodplant families; the aedoeagus of *sanctaecrucis* is stouter than that of *cordiella* and the harpes have two large, comb-shaped papillae, which are only faintly indicated in *cordiella*.

***Acrocercops melantherella* new species**

Antennae slightly longer than forewings, rather thick, dark bronzy brown without color annulations, basal joint moderate smooth. Labial palpi with both joints somewhat thickened with scales, yellowish; terminal joint with a broad dark brown annulation leaving only the tip yellow. Maxillary palpi yellowish with a narrow dark brown annulation at base of terminal joint. Face and head light yellowish brown, thorax darker brown. Forewings light brown dusted with dark purplish brown, especially on costal half; a small light ochreous costal spot at basal third, a larger outwardly oblique ochreous streak before the middle of costa; a small ochreous costal at apical third and a narrow transverse light ochreous fascia across the wing at apical fifth; a small ochreous spot on apex with apical cilia of some color; cilia otherwise dark brown. Hindwings dark purplish fuscous with lighter cilia. Abdomen dark fuscous above with light ochreous underside and anal tuft. Legs ochreous with heavy blackish brown annulation; posterior tibiae above and below with stiff bristles, which are continued on upper side of first tarsal joint.

Alar expanse.—7 mm.

Type.—U. S. National Museum Cat. No. 44145.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Melanthera deltoidea*. (A. R. Otero No. 9548.)

An obscurely colored species which looks like a *Marmara* except for the bristles on the hind tibiae; the roughened palpi and thick antennae are rather unusual in the genus.

***Acrocercops clitoriella* new species**

Antennae slightly longer than forewings, light fuscous with faint darker annulations and light ochreous towards the tip; basal joint short, smooth. Labial palpi with both joints

slightly thickened with scales, light ochreous, with tip of second and an annulation near the tip of terminal joint black. Maxillary palpi ochreous. Face and head light ochreous. Thorax darker ochreous, fuscous. Forewings dull ochreous, heavily overlaid with blackish fuscous scales; three narrow and faint, outwardly oblique, ochreous white streaks cross the wing, from basal third, middle, and apical third of costa; two small opposite costal and dorsal spots of same color just before apex. Hindwings dark fuscous. Abdomen dark fuscous above, underside of body light ochreous. Legs ochreous, tarsi with heavy blackish brown annulations; posterior tibiae above with a double row of spines.

Alar expanse.—7 mm.

Type.—U. S. National Museum Cat. No. 44136.

Type locality.—Baraguá, Cuba. (H. K. Plank.)

Foodplant.—*Clitoria* sp.

An obscurely colored species close to *A. melantherella*.

Acrocercops rendalli Walsingham

Dialectica rendalli Walsingham, Proc. Zool. Soc. London, p. 151, 1897.

Acrocercops rendalli Meyrick, Gen. Ins., Fasc. 128, p. 16, 1912; Forbes, Sci. Surv. Porto Rico, vol. 12, part 1, p. 144, 1930.

Accepting for the present as correct Dr. Wm. Forbes's and my own identification of this species, reared from a malvaceous weed in Porto Rico, I have no specimens of it from Cuba, but it presumably occurs there. It was described from Jamaica and in view of the three following very similar new species there is some doubt of the determination. It is a good example of the futility of mere color description even when the pattern is striking. Superficially these species are so much alike that even a careful worker would be apt to call them the same species, if foodplants were not known and genital structures were not examined. The Porto Rican species agrees best with Walsingham's description, which does not mention the edging of the transverse markings with thin lines of black scales, conspicuous in the following species, but these are fugitive and may have been rubbed out in both the Porto Rican specimens and Walsingham's unique type. The costal edges of the harpes in this species are slightly concave, thickened and chitinized on basal half, sacculus evenly rounded, apex pointed; the anterior process of the vinculum is evenly rounded, thus differing from the following species.

Acrocercops maranthaceae new species

Labial palpi smooth, white, second joint longer than second, somewhat thickened with appressed scales, blunt; maxillary palpi short, white, terminal joint smoky, nearly black. Tongue more than twice as long as labial palpi, white. Antennae longer than forewings, basal joint white with small scale flap light fuscous; basal third whitish, getting smoky outwardly, apical half dark fuscous. Face and head pearly white. Thorax with anterior edge broadly light brown.

Forewings light brown with pearly white transverse markings; a white fascia at basal third is narrow on the costal edge and broadens out across the wing to dorsum, where its width is more than twice the width on costa, both edges margined with black scales; just beyond middle of costa is a second white, outwardly oblique, black-margined fascia with nearly parallel edges but slightly enlarged on dorsum; at apical fourth a round, white, black-edged costal spot and midway between this and the second fascia a thin, outwardly oblique, white, black-edged costal streak; on extreme apex and extending into base of cilia a small transverse white spot edged exteriorly by a short black line in the cilia; apical cilia whitish fuscous, dorsal cilia dark brownish fuscous.

Hindwings and cilia dark brownish fuscous. Legs white, heavily barred with blackish brown; tarsal joints white, tipped with brown; posterior tibia with stiff spines above, which extend out on first tarsal joint. Abdomen yellowish brown above, silvery white on the underside.

Male genitalia with harpes elongate, narrowed at apical third and slightly wider beyond; vinculum with triangular pointed anterior process; aedoeagus long, stout, straight. Female bursa elongate, with a stout two-pronged signum one-third as long as bursa.

Alar expanse.—7 mm.

Type.—U. S. National Museum Cat. No. 44147.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Maranthaceae* sp. (Leaf-miner, A. R. Otero, No. 9639.)

Acrocercops cissiella new species

Coloration and pattern so similar to those of the foregoing species that description of these is nearly a repetition and, allowing for some slight individual variation, hardly sufficient for specific differentiation. The palpi and head, the thorax, and the white markings on the forewing are, how-

ever, more yellowish, ivory white; the scaleflap on first antennal joint is larger; the white outwardly oblique costal streak at apical third is larger and has a minute opposite dorsal white fleck; the white costal spot at apical fourth is also larger than in the foregoing species and reaches nearly across the wing with a few white dashes in the opposite dorsal cilia; the apical white spot and its perpendicular black border are more prominent and the apical cilia are white.

The female bursa contains a very stout three-pronged signum, half as long as the length of the bursa and strikingly larger and stouter than that of the species.

Alar expanse.—7 mm.

Type.—U. S. National Museum Cat. No. 44148.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Cissus* sp. (Leaf-miner, Otero No. 9578.)

The different foodplant and the very much larger signum in the female preclude this from being a variety of the foregoing species and clearly establish its specific validity.

Acrocercops ipomoeae new species

Labial palpi smooth, slightly thickened with scales, pearly white; second joint with narrow longitudinal streak on outer side and tip blackish brown. Maxillary palpi white with blackish brown terminal joint. Antennae light fuscous, first joint white with a rather well-developed scaleflap white with black tip. Face and head pure white; thorax white with base of shoulder-flaps and extreme posterior tip light brown.

Forewings light golden brown with white markings occupying the larger part of the surface; from basal third of costa a very broad white fascia more than twice as broad on dorsum as on costal edge, reaching there nearly to the base of the wing; a similarly shaped transverse white fascia at apical third, like the first slightly edged with blackish brown scales, especially on outer margins; at apical fifth a large, elongate, white costal spot extended outwardly in an oblique white streak reaching nearly across the wing to an opposite, elongate, dorsal white spot; the dorsal cilia bordering this spot white, cilia otherwise golden brown.

Hindwings dark brownish fuscous with lighter cilia. Abdomen brownish fuscous above with silvery white underside. Legs white, heavily barred exteriorly with blackish brown, anterior and middle tibia slightly thickened with scales, posterior tibia with stiff bristles above extending out on first tarsal joint; tarsal joints white with light brown annulation.

Male genitalia with harpes strongly spined on outer surface and with outer half of both edges fringed with closely set dark-colored bristles; aedoeagus long, slender, straight, vinculum with anterior process long tongue-shaped. Female bursa elongate oval with seven small biforked signa set in a circle around the middle.

Alar expanse.—7 mm.

Type.—U. S. National Museum Cat. No. 44149.

Type locality.—Santiago de las Vegas, Cuba.

Foodplants.—*Ipomoea* and *Jaquemontia*. (Leaf-miner, Otero No. 9716–9463.)

While of the same group as the three species treated above, this species is readily recognized by its pattern and more golden color. The genitalia are of the same general type, but at once distinguished by the fringed and spiny harpes, the tongue-shaped process of the vinculum, and in the female by the multiple small spines of the same general shape as the single larger signum in the foregoing species.

Neurostrata gunniella Busck

Gracilaria gunniella Busck, Proc. U. S. Nat. Mus., vol. 30, p. 731, 1906.

Acrocercops gunniella Meyrick, Gen. Ins., Fasc. 128, p. 16, 1912.

Neurostrata gunniella Ely, Proc. Ent. Soc. Wash., vol. 19, pp. 41, 68, 1917.

This striking species was described from Brownsville, Texas, and had not been received since. Mr. Otero has succeeded in rearing a series from *Mimosa asperata* in Cuba. Although of normal Gracilariid type, the larvae are true stem-borers in this plant, not merely mining under the epidermis of the plant like the species of the genus *Marmara*, but actually boring into the pith of the stem, a very unusual mode of life in the family *Gracilariidae*. On maturity the larva comes out of the stem for pupation in a cocoon.

The genus *Neurostrata* possesses a wing character not described by its author, namely, a very strong frenulum-like spine from the pronounced costal shoulder of the hindwing at one-third from base, stouter even than the frenulum itself, which is present in its normal position.

The closely allied genus *Neurobathra* Ely, which differs mainly in the modification of the hindwings of the male, shows a corresponding character in three costal spines arising from the same

place, and the genus *Micrurapteryx* Spuler likewise has three or more stiff costal bristles on the shoulder of the hindwing, although not so strongly developed as in the two other genera.

The male genitalia of *N. gunniella* have the harpes rhombic, short and broad, with costa and sacculus straight, parallel, and apical edge oblique, parallel with the base of the harpe; vinculum with short pointed anterior process; aedoeagus long, nearly straight, pointed; eighth abdominal segment with a pair of curved hair pencils. Bursa of the female with two large oblong forked signa.

Neurostrata pithecolobiella new species

Labial palpi with second joint and basal half of third joint thickened with outwardly increasing heavy scaling, abruptly cut off before apex leaving the very attenuated tip of third joint smooth; base and inner sides white, outer part of scaling blackish. Maxillary palpi short, slightly tufted at tip, white. Antennae longer than wing length, shiny blackish fuscous. Face white. Head light brown with darker fuscous side tuft. Thorax light brown with dark fuscous shoulders. Forewings light ochreous brown with costal edge broadly suffused with bluish black scales; bluish black first and second discal spots more or less confluent with the dark costa; a narrow outwardly curved irregular fascia just before apex and a large spot on apex, shiny bluish black, with a thin edge of the wing light brown. Four minute light ochreous nearly white costal dots on outer half. Base of cilia broadly shiny, bluish black, tips of cilia mixed with light brown; costal cilia long and abruptly cut off at apex; dorsal cilia short giving a hook-like appearance to the wing. Hindwings blackish fuscous. Abdomen dark fuscous above, underside lighter, male genitalia and two curved hair pencils on eighth abdominal joint light ochreous. Legs light ochreous on their inner sides, blackish fuscous on their outer side; tarsi light ochreous, each joint slightly tipped with black.

Male genitalia with harpes elongate, costa broadly thickened, sinuate, apex produced, outer edge sinuate, aedoeagus short, robust; eighth abdominal segment with two long, curved hair pencils. Female bursa with two large elongate pronged signa.

Alar expanse.—9–10 mm.

Type.—U. S. National Museum Cat. No. 44150.

Type locality.—Santiago de las Vegas, Cuba. (A. R. Otero.)

Foodplant.—*Pithecolobium saman*. (Otero No. 9683.)

The curious scaling of the labial palpi, reminding one of the genus *Epermenia*, is unique in the family so far as known and at once distinguishes this pretty species, but does not, in my judgment, necessitate generic separation.

The larva, of typical Gracilariid form, feeds in the stem of *Pithecolobium*. When mature it emerges and spins a narrow cocoon in the folded edge of a leaf and ornaments it with twenty or more pearly white composite air bubbles, voided from the anus and stuck out through slits in the cocoon, which are afterwards spun together again, as is the rule in the genus *Marmara*.

***Neurobathra curcassi* new species.**

Second joint of labial palpi with well-developed triangular tuft, dark fuscous with extreme base and apex and with the tips of the brush scales white; terminal joint white. Maxillary palpi fuscous with white tips. Head light ochreous fuscous. Thorax light fuscous with dull ochreous lateral stripes. Forewings dark fuscous on costal half, lighter, ochreous fuscous on dorsal half; costal edge from middle of wing nearly to apex narrowly ochreous white; from middle of costa a very outwardly oblique ochreous white streak and from apical third of costa a similar streak; two dorsal very outwardly oblique white streaks nearly opposite the costal streaks but slightly nearer base; just before apex a blackish brown oval spot; cilia dark fuscous tipped with white. Hindwings dark fuscous with slightly lighter cilia. Abdomen dark fuscous above, underside of entire body silvery white. Legs dark fuscous with white annulations.

Alar expanse.—10 mm.

Type.—U. S. National Museum Cat. No. 44151.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Curcas curcas*. (Otero No. 9591.)

Close to the foregoing species and to the North American genotype *N. strigifinitella* Clemens.

Neurobathra albomarginata Walsingham

Coriscium albomarginatum Walsingham, Proc. Zool. Soc. London, p. 154, 1897.

Parectopa albomarginata Meyrick, Gen. Ins., Fasc. 128, p. 21, 1912.

Acrocercops albomarginata Forbes, Sci. Surv. Porto Rico, vol. 12, p. 112, 1930.

Described from St. Thomas and recorded from Porto Rico by Forbes, but foodplant hitherto not ascertained. Mr. Otero reared the species repeatedly from leaf-mining larvae of *Bradburya plumbieri*. (Otero No. 9679.)

Gracilaria perseae Busek

Gracilaria perseae Busek, Proc. Can. Ent., vol. 52, p. 239, 1920; Moznette, U. S. Dept. Agr. Farmers' Bull. No. 1261, p. 20, fig. 15, 1922.

The avocado leaf-roller, described from Florida, where it is at times seriously injurious to the young growth. Dr. Bruner reared this from avocado, *Persea perseae*, at Santiago de las Vegas, Cuba. (No. 9086.)

FAMILY HEMEROPHILIDAE

Mictopsichia gemmisparsana Walker

Gauris gemmisparsana Walker, Cat. Lep. Brit. Mus., vol. 28, p. 415, 1863.

Mictopsichia gemmisparsana Walsingham, Biol. Cent. Amer., vol. 4, p. 306, 1914; Meyrick, Am. Naturhist. Mus. Wien., vol. 44, p. 261, 1930.

The foodplant of this common tropical species has not, so far as I know, been ascertained before. Mr. Otero has succeeded in doing so by rearing a series from *Cissus sicyoides* on which the larvae are leaf-tyers. This is the first West Indian record of the genus.

Usara eurythmiella Busek

Ussara eurythmiella Busek, Proc. U. S. Nat. Mus., vol. 47, p. 59, 1914.

This exquisite little species was described from Porto Bello, Panama (Busek coll.). Mr. Otero has succeeded in rearing the species in Cuba from two pepper plants, *Piper aduncus* and *P. auritum* (Otero No. 9850). This is the first record of the early stages of the genus. The larva spins a very characteristic open network cocoon, intermediate between that of *Plutella* and that of *Urodus*, attached flat on the leaf like the former, but built up of thick, tough, transverse strands, connected with thick longitudinal lines, forming regular rectangular windows, through which the pupa can be seen; at each end there is a prolonged longitudinal slit; through the posterior slit the larval skin is thrown out; through the anterior slit the adult emerges, leaving the pupal skin within the cocoon; on the anterior third of the cocoon is an elevated

hump or shoulder, supported by the heaviest strand of silk, which probably is the first part made.

The cocoon is 10 mm. long by 3.5 mm. wide at its broadest part, tapering towards both ends. The cocoons varied from light yellow to dark brown in color, probably due to exposure or moisture.

The pupa is light yellow with dark brown pattern on the abdominal joints and with the spiracles on dark brown, protruding, lateral tubercles on second to eighth abdominal joints, small on the first three and the last, very prominent on the sixth and seventh joints which are free and movable; anal joint without cremaster, but with a cluster of small ventral hooks; wing covers and tips of antennae and legs reaching to middle of fifth abdominal joint. Length of pupa 7 mm.

Brenthia pavonacella Clemens

Brenthia pavonacella Clemens, Proc. Acad. Nat. Sci. Phila., p. 172, 1860; Stainton (Clemens) *Tineina* N. Amer., p. 134, 1872; Zeller, Hor. Soc. Ent. Ross., vol. 13, p. 174, 1877; Moeschler, Abh. Senck. Nat. Ges., vol. 16, p. 335, 1890; Walsingham, Proc. Zool. Soc. London, p. 120, 1897, Bio. Cent. Amer. Lep., vol. 4, p. 307, 1914; Meyrick, Gen. Ins., Fasc. 164, p. 24, 1914; Wolcott, Journ. Dept. Agr. Porto Rico, vol. 7, p. 205, 1923; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 102, 1930.

Choreutis suavis Felder, Reise Novara, pl. 138, fig. 3, 1875.

This common North American species extends to Brazil and has been repeatedly recorded from the West Indies. Mr. Otero sent a series labeled: "common on *Bradburya plumieri*," which may well be a foodplant; in North America the larvae feed normally on other leguminous plants, *Amphicarpaea* and *Desmodium*.

Like several other species of the family, the moths can often be observed "dancing" in circles on leaves, displaying their hind-wings.

Brenthia sapindella new species

Labial palpi white, second joint with extreme base and a small outer spot before apex blackish brown, terminal joint with extreme base and extreme tip blackish brown. Antennae dark purplish brown with a thin white line on under-side from base to tip and with a single white scale on upper side of each of the first eight or ten joints. Face white with a central brownish gray line. Head blackish brown. Thorax blackish brown with a thin transverse white line and with

small lateral white dashes on anterior edge; shoulder-pads narrowly edged with white. Forewings blackish brown irrorated with white and bluish metallic scales; a narrow, incomplete, and ill-defined white transverse streak near base, a broad middle area of white reticulation, broadest on dorsum and not reaching costa, edged costally by heavy bluish metallic streaks; outer third of wing but sparsely sprinkled with white but with a prominent transverse white spot on the end of the cell; apical and terminal edges broadly lined with bluish metallic scales; cilia dark brown with a broad white pencil at apex and a smaller pencil near tornus. Hindwings blackish brown with base of costa and a broad streak from there to middle of cell white; a white costal dash at apical third; an oblique white streak across veins 3 to 5 and a thinner white line across vein 2; inner edge touched with white; the white markings are tipped by bluish metallic scales and a broad bluish metallic fascia crosses the tip of the wing; cilia blackish brown, with apical part and a smaller terminal area broadly tipped with white.

Underside of both wings with the upper pattern repeated; on the hindwing even emphasized and with much heavier sprinkling of the bluish metallic scales, this side is the most conspicuously displayed, when the moths "dance" around with the hindwings lifted at right angles to the forewings. Abdomen dark brown above, underside of entire body silvery white. Legs white with narrow blackish brown annulations.

Alar expanse.—10 mm.

Type.—U. S. National Museum Cat. No. 44152.

Type locality.—San Diego de los Baños del Río, Cuba.

Foodplant.—*Sapindus saponarius*, (Otero No. 9809).

Very similar to the genotype but larger and differing in details of ornamentation as well as in genitalia; nearest to *Brenthia ocellata* Walsingham, but also amply distinct in structure from this Central American species.

The foodplant of only one species of the genus was hitherto known and the assumption from this species that the genus was confined to leguminous plants is interestingly disproven by Mr. Otero's rearing the present species from such a widely different plant family as the *Sapindaceae*.

Tortyra ignita Zeller

Choregia ignita Zeller, Hor. Soc. Ent. Ross., vol. 13, p. 195, 1877.

Tortyra auriferalis Walsingham, not Walker, Proc. Zool. Soc. London, p. 528, 1891; p. 121, 1897; Meyrick, Gen. Ins., Fasc. 164, p. 19, 1914.

This species has mistakenly been considered identical with Walker's San Domingo species, *T. auriferalis*, by Walsingham and Meyrick, who both mistakenly added other synonyms to Walker's name. Almost every island and locality on the mainland has its own species of this genus, presumably feeding on different species of *Ficus*. The very similar pattern and strong metallic colors of these beautiful insects have occasioned the muddled synonymy in this genus, as has been the case in other groups with striking pattern and colors, but careful examination easily discloses constant differences of color and pattern and the genitalia prove that these forms are not merely local varieties, but good valid species which do not interbreed.

The present species is particularly easy to differentiate by the characters given by Zeller, who correctly diagnosed it as distinct, and it is very different from the larger, more pointed-winged, golden metallic San Domingo species described by Walker, which is nearer, although also very different from the following new species.

***Tortyra vividis* new species**

Labial palpi metallic fuscous, with a green and silvery sheen; tip of terminal joint somewhat darker, dull, not metallic. Antennae dilated and ciliate in the male, dark metallic bluish fuscous. Face golden.

Head and thorax strongly metallic golden purple. Forewings with ground color dull purplish brown finely irrorated with thin transverse lines of bluish white scales; dorsal half of basal third heavily overlaid with green metallic scales; transverse fascia before middle of wing metallic green, nearly straight, bordered on both sides with straight dark purplish brown lines, the inner one of which does not reach costa; the entire tornal triangle from apical third of dorsum to apex strongly metallic green. Hindwings dark dull brown with costal edge white on basal two-thirds and with cilia whitish fuscous. Abdomen dark brown. Legs dark purplish brown with metallic sheen, tarsi with faint whitish annulations.

Alar expanse.—17 mm.

Type.—U. S. National Museum Cat. No. 44153.

Type locality.—Sierra Maestra, East Cuba, 1,000 feet alt. (O. Querci Coll., January.)

Choreutis leptilonella new species

Labial palpi dark ochreous brown, much sprinkled with white scales and with inner side of second joint white. Antennae dark brown, annulated with silvery white. Face and head dark ochreous-brown. Lower face and underside of thorax silvery white. Thorax above dark ochreous-brown with a thin longitudinal central line of white scales and shoulders touched with white. The dark ochreous-brown ground color of the forewings nearly obscured by blackish-brown, golden ochreous, white, and silvery scales; from base of wing below costal edge a golden ochreous longitudinal line, edged above with metallic silvery scales; at basal third a broad, diffused, irregular, transverse cloud of white scales across the wing; at apical fourth a somewhat defined, narrow, outwardly angulated, white-dotted fascia, beyond which the tip of the wing is golden brown with sparse white single scales and groups of silvery metallic scales; two similar groups of silvery metallic scales at base of the wing, two larger ones on the middle of the wing, and a transverse streak of silvery scales on the end of the cell, edged on both sides with blackish-brown. Cilia bluish black. Hindwings dark blackish-brown with costal edge white and with a slight sprinkling of single white scales parallel to termen. Abdomen blackish-brown with narrow white annulations. Legs yellowish white with heavy black bars on tibiae and blackish-brown annulations on tarsi.

Female genitalia with rather short ductus, the first half of which is strongly chitinized and pouched, the other half thin-walled; bursa elongate ovate with two large, unequal, longitudinal, feathery signa. The five reared specimens before me are all females, hence I am, at present, unable to describe the male genitalia, which, however, undoubtedly will conform to the generic type, the species being in all other respects typical of the genus.

Alar expanse.—12 mm.

Type.—U. S. Nat. Museum Cat. No. 44154.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Leptilon* sp. (*Erigeron*). (Otero No. 9511.)

FAMILY PLUTELLIDAE

Acrolepia cestrella new species

Second joint of labial palpi with well developed triangular tuft on underside, terminal joint longer than second, thickened with scales, apex bluntly pointed; light ochreous,

darker ochreous on outer side and sprinkled with black scales. Maxillary palpi short, porrected, dark ochreous. Face smooth, light ochreous. Thorax and forewings whitish ochreous strongly suffused with dark ochreous-brown and sprinkled with sparse black scales; an indistinct series of small, equidistant black streaks on costal edge; two triangular, nearly clear white dorsal spots, one at basal fourth, the other on the middle of the wing, the latter edged by a few black scales; a third smaller, white dorsal spot, just before the cilia, is also edged with black; a thin incomplete transverse line of black scales at apical fourth and a few white and black scales at apex; cilia dark ochreous brown, tipped with black. Hindwings dark fuscous with lighter cilia. Venation typical of the genus; forewings with 12 veins all separate, 7 to below apex, 1b furcate at base, 1c present in its entire length. Hindwings with 8 veins, 3 and 4 stalked, 7 parallel to 6.

Male genitalia typical of the genus, vinculum with very long, stout, anterior process; aedoeagus long, straight, bulbed at base; harpes slender, pointed; eighth segment with two long expansible hair pencils. Female genitalia with ductus rather short, looped, posterior half strongly chitinized; bursa oblong oval, without signum.

Alar expanse.—12–13 mm.

Type.—U. S. National Museum Cat. No. 55155.

Type locality.—Santiago de las Vegas, Cuba.

Foodplant.—*Cestrum diurnum*. (Otero No. 9500.)

This is the first record of this genus from the West Indies. The species is typical in all respects and resembles in coloration the European *A. assectella* Zeller.

Plutella maculipennis Curtis

The common cosmopolitan so-called diamond-back cabbage moth has not previously been recorded from Cuba, although it was expected to be present there. Mr. Harold K. Plank has sent me a series from Central Baraguá, Cuba. The species is occasionally injurious to cultivated cabbage, but feeds normally on outer wild *Cruciferae*.

FAMILY TINEIDAE

Tineola uterella Walsingham

Tineola uterella Walsingham, Proc. Zool. Soc. London, p. 165, 1897; Biol. Cent. Amer., vol. 4, p. 368, 1914; Forbes, Sci. Surv. Porto Rico, vol. 12, p. 154, 1930.

Tinea uterella Meyrick, Exot. Micros., vol. 2, p. 595, 1922.

Tinea allutella Meyrick (Rebel?), Exot. Micros., vol. 3, p. 552, 1930.

There are several very similar species of this group, which make similar cases found in houses and on tree trunks in the American tropics. Although describing this species in his West Indian paper, Lord Walsingham made his Brazilian (Pará) specimens the types of his *Tineola uterella* (Biol. Cent. Amer., vol. 4, p. 368, 1914), and I am not convinced that his West Indian (St. Thomas) specimens were truly conspecific. I am inclined to believe that a series in the U. S. National Museum reared from identical cases found in houses in Pernambuco, Brazil, represent the true *uterella* Walsingham. These average somewhat smaller in size and may eventually prove to be the *Tinea borboropis* Meyrick, from British Guiana (Exot. Micros., vol. 2, p. 275, 1919), also described from a mixed series, but afterwards (Exot. Micros., vol. 2, p. 595, 1922) restricted to three out of the eight original specimens, the balance of which Meyrick referred to *uterella*.

Pending reexamination of the types of these species, which alone can definitely clear their status, I retain here Walsingham's name for the commonest West Indian domestic species, which I have collected on St. Thomas and on most of the West Indian Islands. This, however, is the one which presumably eventually will require a new name and if so I propose the name *Tineola walsinghami*. The genitalia of the commonest West Indian and the Pernambuco species are very distinct.

Meyrick has subsequently (Exot. Micros., vol. 3, p. 552, 1930) identified Walsingham's *uterella* as identical with the *Tineola allutella* Rebel, described from the Canary Islands (Ann K. K. Hofmus., vol. 7, p. 270, pl. 17, fig. 3, 1892), but in view of our present knowledge of several closely similar American species of this group, it would be unwise to adopt this very doubtful synonymy and thus further complicate the nomenclature. Lord Walsingham, Mr. Durrant, and the writer discussed the possibility of this synonymy, while comparing a reared series from the Canary Islands with the Walsingham type series at Merton Hall in 1908, but agreed that Walsingham was correct in retaining the two species as distinct in his Teneriffe paper.¹

¹ Since this was written I have studied the types in the British Museum and through the courtesy of Mr. H. Stringer I have made genitalia slides also of authentic Teneriffe specimens of Rebel's species, enabling me to verify my conclusions. *Tineola uterella* Wals-

Meyrick has removed *uterella* from the genus *Tineola* to *Tinea*; the species is somewhat heterogeneous in both genera, both in genitalia and in the larval characters (the very long thoracic legs and the heavily chitinated thoracic plates; the larva of *Tineola biselliella* has no eyespots, those of most *Tinea* species have normal eyespots, that of *uterella* has only one); but the strong antennal pecten and the reduced maxillary palpi cause me to prefer retaining the species in *Tineola* as originally placed.

Dr. Bruner (9418) and Mr. Otero (No. 9799) have both bred this species, provisionally retained as *Tineola uterella*, from flat seed-shaped cases found on inside walls of houses.

So far as the writer has observed the species in the West Indies, the larvae are not cloth feeders, but live on insect remains caught in spiders' webs. The superficially similar Gelechiid, *Oesia maculata* Walsingham, occasionally reared from cases of the same kind as those of the *Tineola*, may prove to be parasitic or predatory on that species.

ingham applies to the Brazilian species, subsequently described as *Tinea borboropis* Meyrick; the West Indian species should be known as *Tineola walsinghami* Busck; aside from the more or less unreliable differences in color and size the genitalia give definite characters; the aedoeagus of *uterella* is strongly serrate exteriorly, that of *walsinghami* is smooth, and the harpes of the two species are quite distinct. The Teneriffe species *Tineola allutella* Rebel is quite distinct from the American species, though belonging to the same group. It has the aedoeagus smooth but has differently shaped harpes.

PLATE XXX

- Fig. 1. *Apotoforma rotundipennis* Walsingham, male genitalia.
Figs. 2-3. *Apotoforma rotundipennis* Walsingham, wing venation.
Fig. 4. *Amorbia phaseolana* Busck, male genitalia.
Fig. 5. *Gymnandrosoma pithecolobiae* Busck, harpe of male genitalia.
Fig. 6. *Ancyliis cordiae* Busck, male genitalia.
Fig. 7. *Ancyliis bauhiniae* Busck, male genitalia.

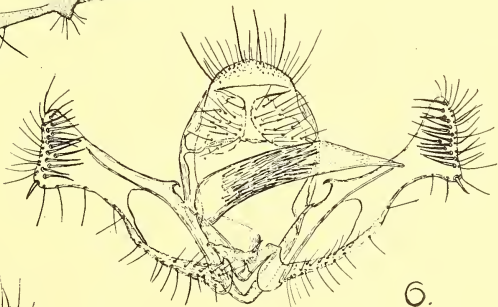
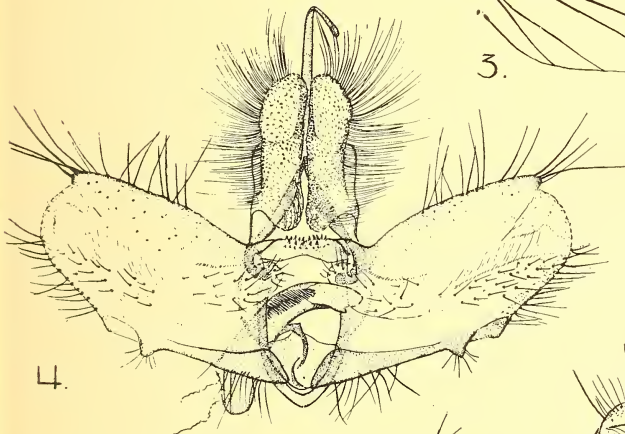
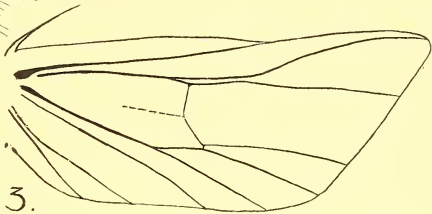
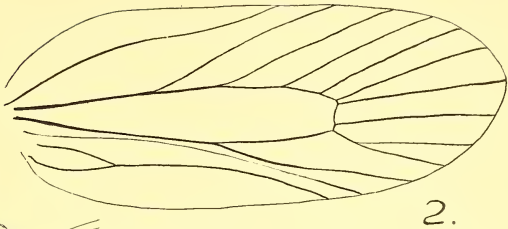
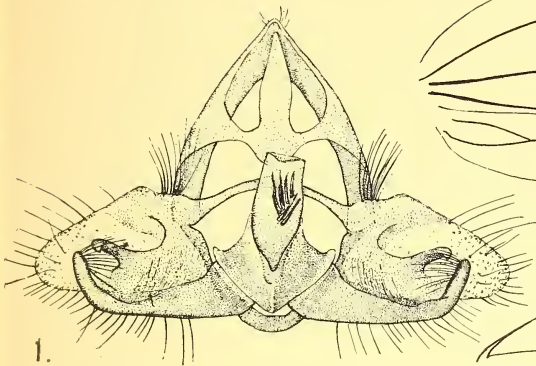


PLATE XXXI

- Fig. 1. *Nealyda bifidella* Dietz, male genitalia, front view.
Fig. 2. *Nealyda bifidella* Dietz, male genitalia, side view.
Fig. 3. *Aristotelia eupatoriella* Busck, male genitalia.
Fig. 4. *Aristotelia eupatoriella* Busck, aedoeagus of male.
Fig. 5. *Stenoma comma* Busck, male genitalia.
Fig. 5 a. *Stenoma comma* Busck, divided hair-scale of harpe.
Fig. 6. *Aristotelia eupatoriella* Busck, female genitalia.
Fig. 7. *Stenoma comma* Busck, female genitalia.
Fig. 8. *Aristotelia eupatoriella* Busck, scale pattern of hind wing.

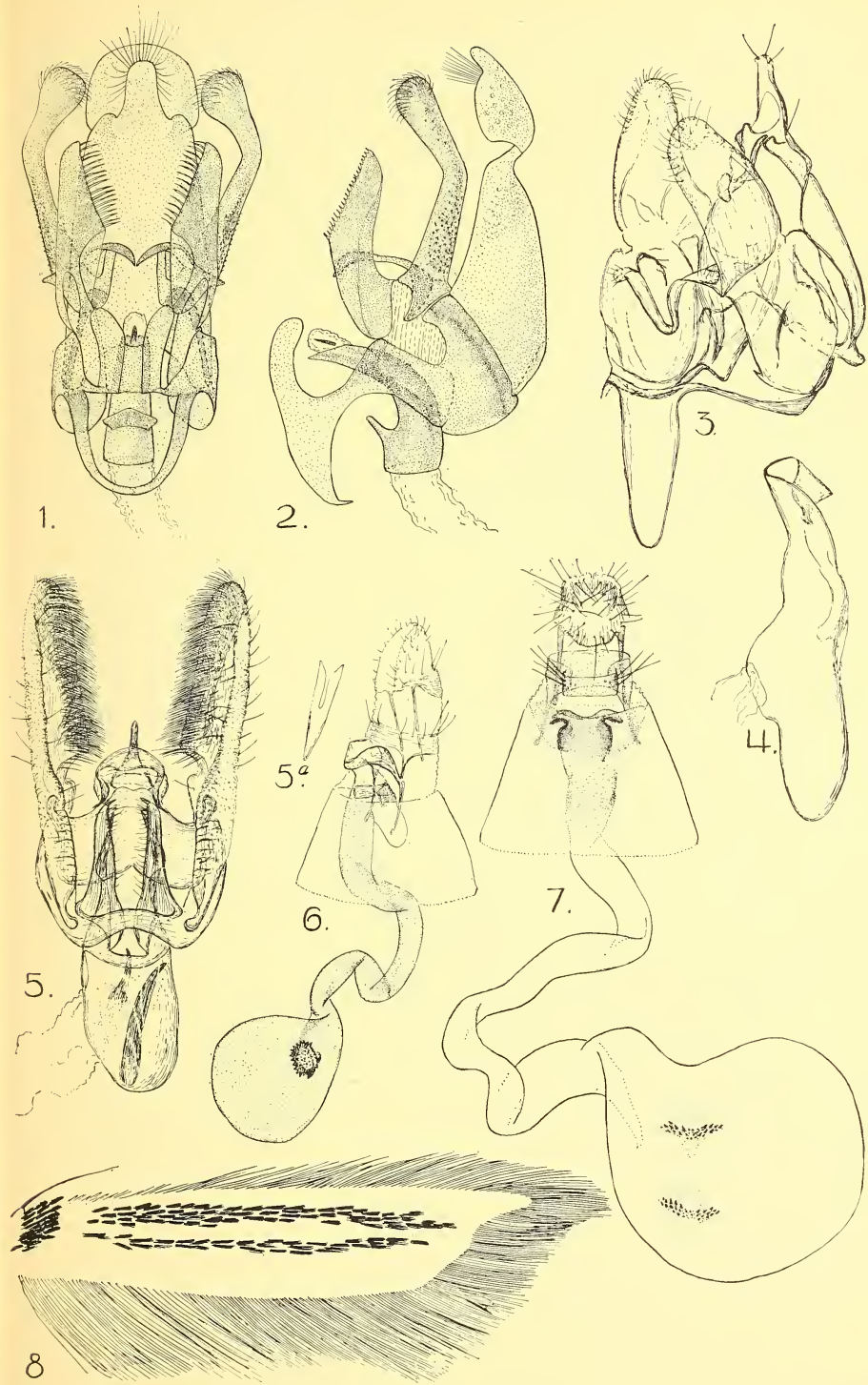


PLATE XXXII

Donacivola saccharella Busek

- Fig. 1. Male genitalia.
- Fig. 2. Aedoeagus of male genitalia.
- Fig. 3. Female genitalia.
- Fig. 4. Wing pattern.
- Figs. 5 and 6. Wing venation.
- Fig. 7. Pupa, in cocoon, lateral view.
- Fig. 8. Pupa, ventral view.
- Fig. 9. Pupa, dorsal view.

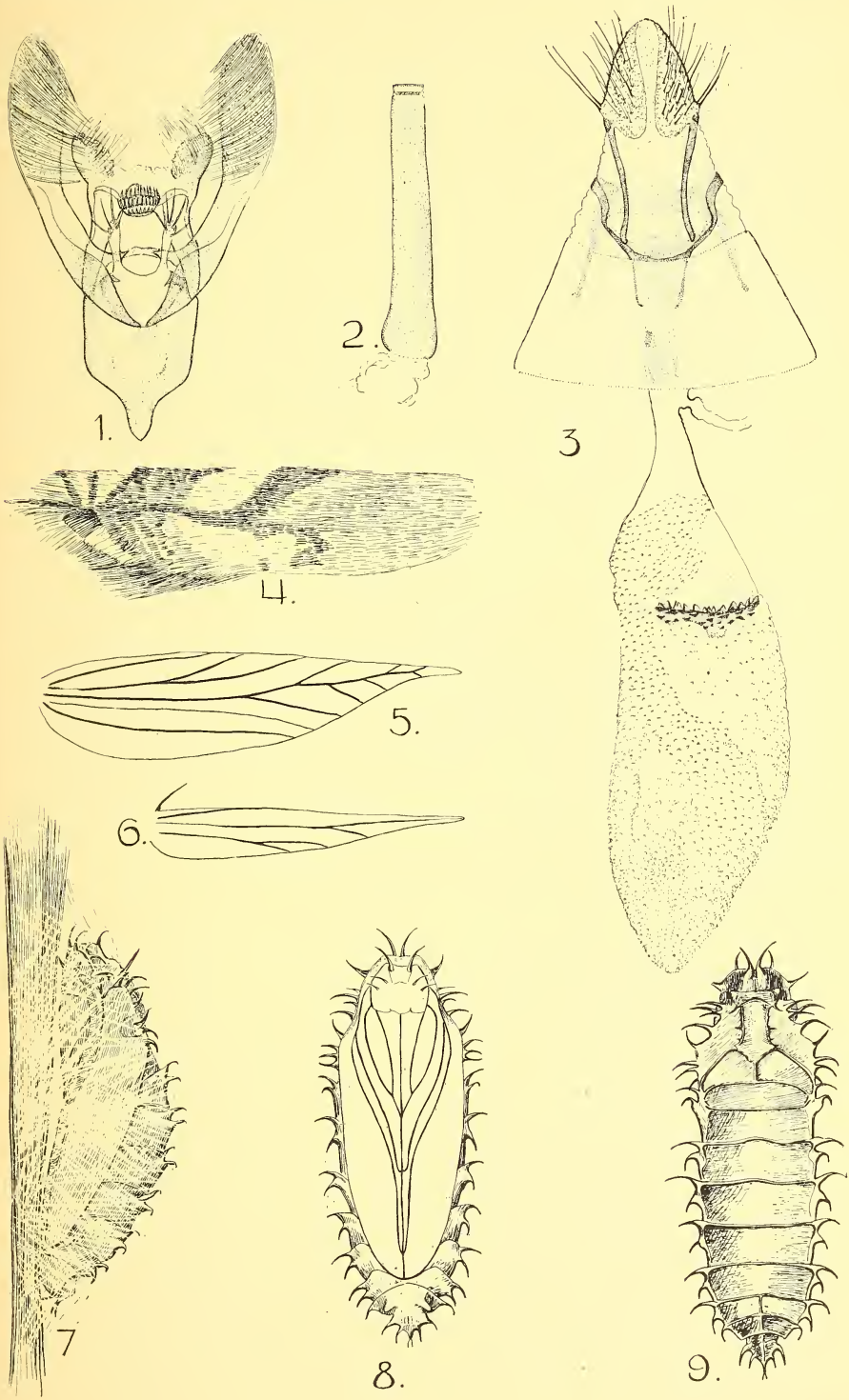


PLATE XXXIII

- Fig. 1. *Ethmia confusella* Walker, male genitalia.
Fig. 1 a. *Ethmia confusella* Walker, aedoeagus.
Fig. 2. *Ethmia cubensis* Busek, male genitalia.
Fig. 3. *Ethmia hiramella* Busck, male genitalia.

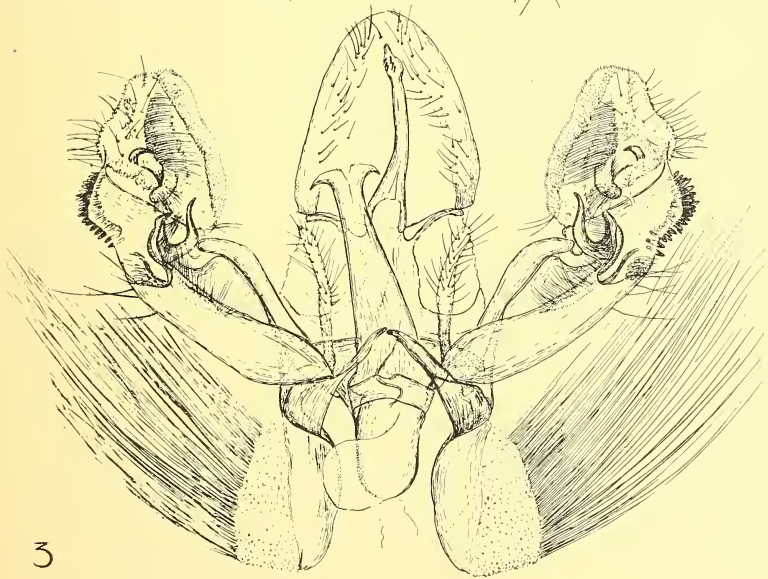
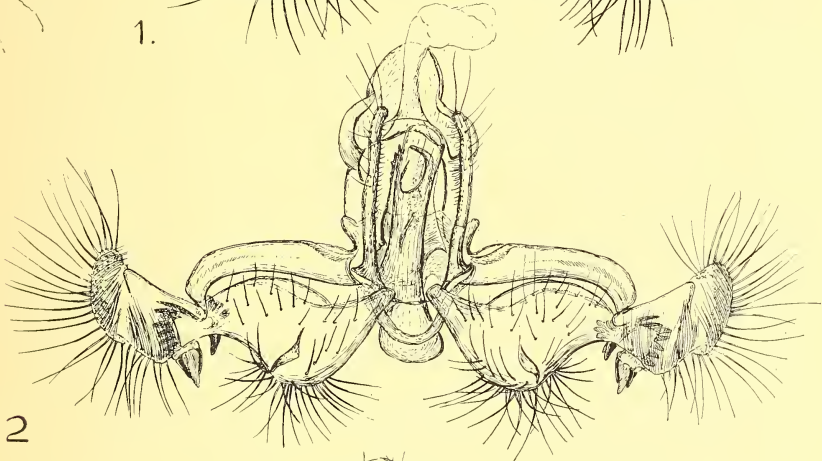
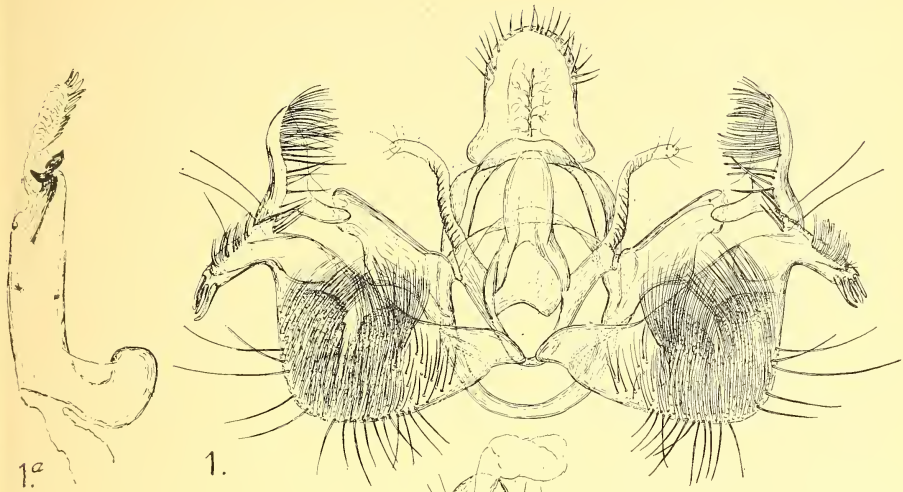
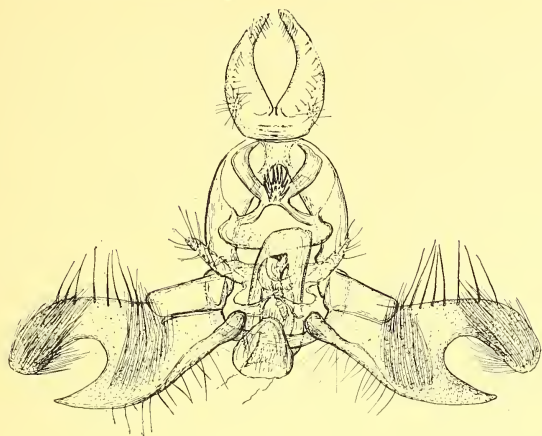
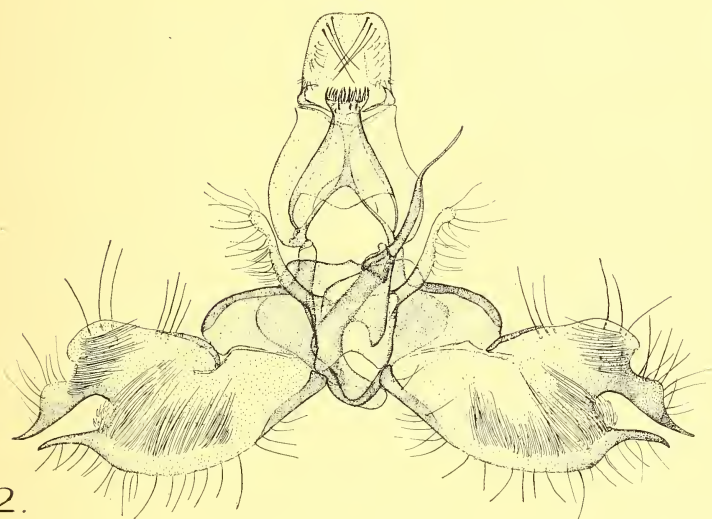


PLATE XXXIV

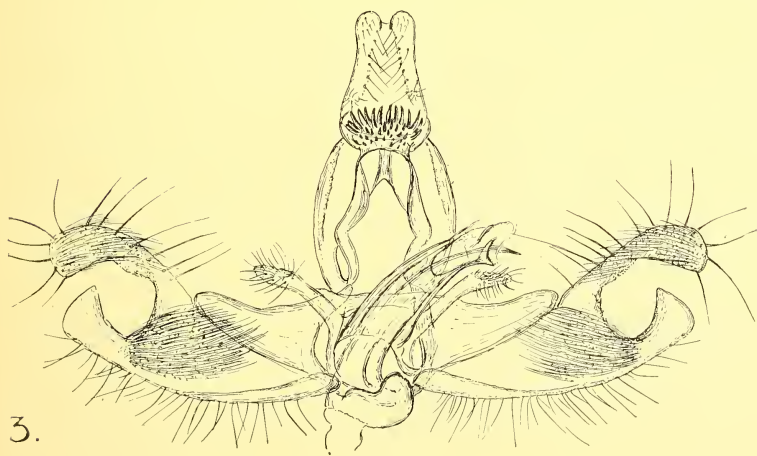
- Fig. 1. *Ethmia clarissa* Busck, male genitalia.
Fig. 2. *Ethmia subsimilis* Walsingham, male genitalia.
Fig. 3. *Ethmia nivosella* Walker, male genitalia.



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2.



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PLATE XXXV

- Fig. 1. *Ethmia scythropa* Walsingham, male genitalia.
Fig. 2. *Ethmia ornata* Busck, male genitalia.
Fig. 3. *Ethmia exornata* Zeller, male genitalia.

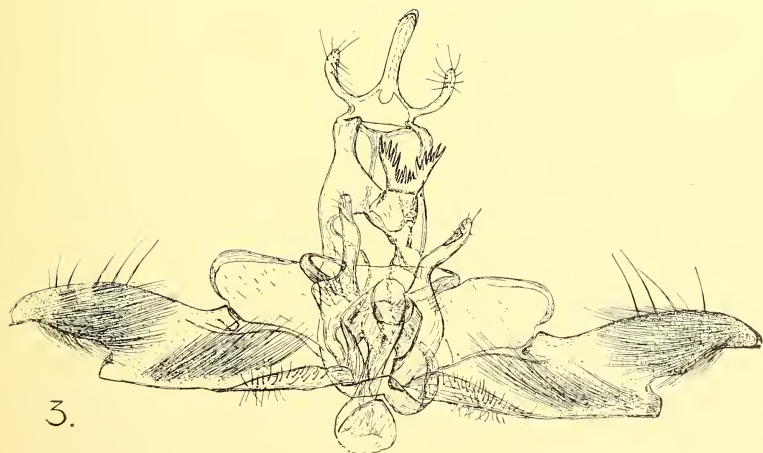
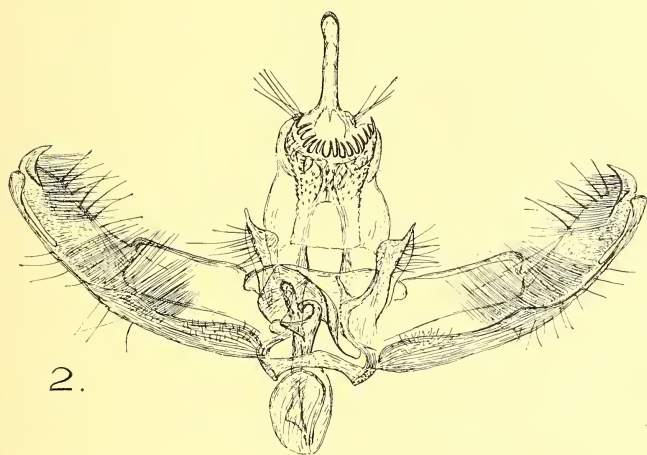
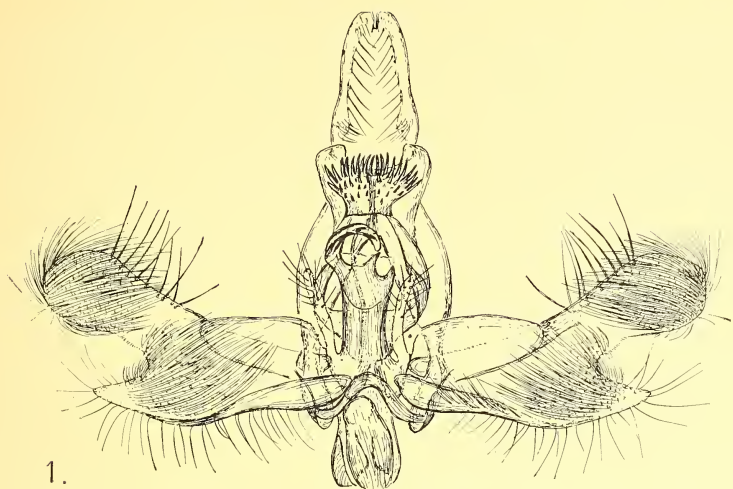
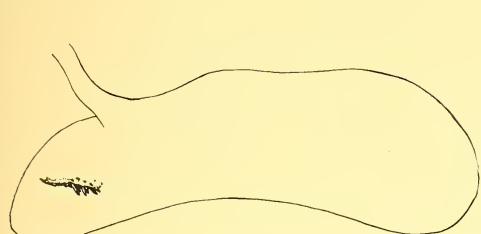


PLATE XXXVI

Female genitalia

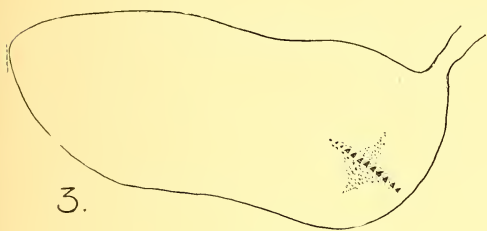
- Fig. 1. *Ethmia nivosella* Walker.
- Fig. 2. *Ethmia submissa* Busck.
- Fig. 3. *Ethmia cubensis* Busck.
- Fig. 4. *Ethmia oterosella* Busck.
- Fig. 5. *Ethmia subsimilis* Walsingham.
- Fig. 6. *Ethmia scythropa* Walsingham.
- Fig. 7. *Ethmia confusella* Walker.
- Fig. 8. *Amorbia phaseolana* Busck.
- Fig. 9. *Apotoforma rotundipennis* Walsingham.



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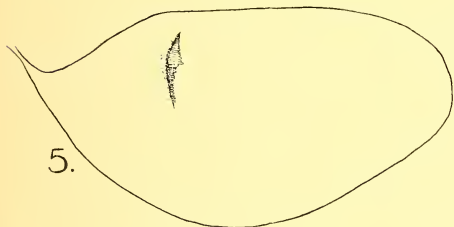
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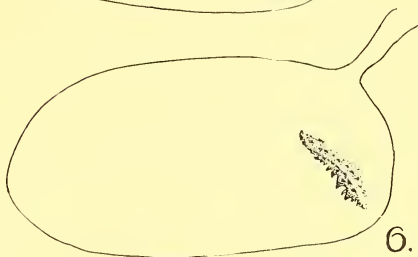
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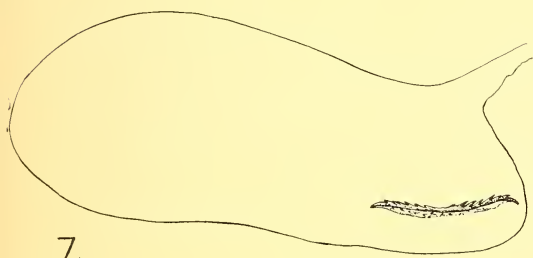
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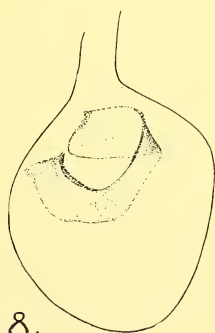
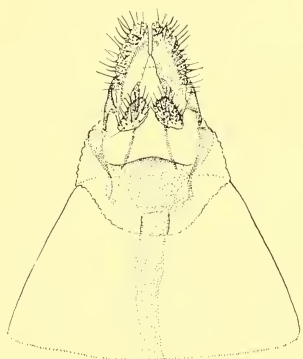
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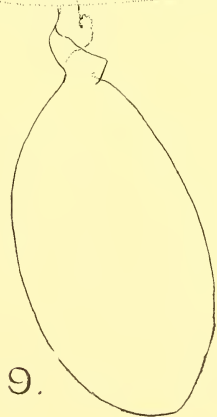
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9.

ENTOMOLOGICA AMERICANA

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All names arranged alphabetically. Valid names in Roman; synonyms in *italics*; now genera and species in **bold face**; * indicates plants; † indicates other animals.

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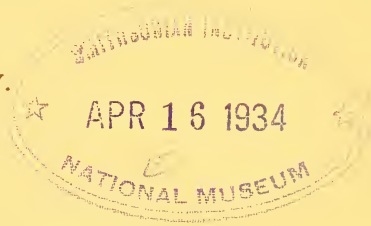
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No. 1

A GROUPING OF THE AGROTINE GENERA

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The Agrotines have always been a difficult region in our classification of the Noctuidae. While perhaps not as complete a mystery as the series called Acronyctinae by Hampson, there has never been any agreement as to the content of the group, the manner of subdivision, or the relative importance of the various characters. There has been a tendency to make arrangements frankly artificial, and where the published statements seem to imply a certain amount of natural grouping¹ these groupings agree neither with each other, nor wholly with the only well marked larval character, the rough or smooth skin. There are two other questions which are rather of

¹In Hampson's case the presentation of a phylogeny implies that a natural system is intended, but he puts forms in fact just as they would go according to his key-characters, frequently in violation of well known larval and other characters, and the "phylogeny" would appear to be really intended merely as a key to his seriation of genera. In the case of McDunnough's revision (Bull. no. 55, National Museum of Canada) the arrangement is also in part confessedly artificial but certain groups appear to be presented as natural in the discussion on p. 19, namely *Euxoa* to *Pseudorthosia*, *Trichosilia* to *Actebia* or less definitely to *Euagrotis*, *Metalepsis* and *Cerastis*, *Hemipachnobia* to *Pseudospaelotis*, with *Peridroma* (attached to the first group), *Diarsia* to *Anomogyna*, *Trichagrotis* to *Mimobarathra*, *Adelphagrotis* to *Pseudoglaea*, and *Cryptocala* to *Pronoctua*, the two latter groups again taking up the *Euxoa* series.

nomenclature than of taxonomy in the true sense, namely as to the proper size for genera, and the names to apply to them. In the first case I should go much less far than McDunnough in subdivision, believing that a somewhat larger genus is of more use to the general entomologist, and that the minute subdivision that the taxonomist desires can best be accomplished by subgenera. I have suggested a list of some 20 genera, representing the principal structural types and the most striking aberrant ones, but there is a good deal to say for the general European custom of putting all the normal members of the series in a single genus (*Agrotis*). There is of course no justification for the equally common European custom of making a separate genus for the yellow-winged ones (*Triphaena*) as they are not at all a natural group. As to the names to use, I have followed McDunnough's list for convenience of cross-reference, in the case of what I consider mere subgenera, but have been unwilling to drop the traditional name of *Noctua*, and so have applied it to the genus to which it has on the whole been most consistently applied, on the ground that it is suitable for a conservanda ruling. So I shall use it for the group containing *triangulum* and *c-nigrum* (*Graphiphora* of McDunnough, etc.) though frequently using the name *Graphiphora* when referring to McDunnough's revision.

The present paper leans heavily on McDunnough's revision (cited in the first footnote). I will limit myself in general to his genotypes, as in a good many cases where I have studied other species which he places in the same genus, I agree that they are too closely related to worry over. In the case of North American material I shall consider the same series of forms, since on the whole they represent a natural subdivision, but have expanded the view to include a number of the more important genotypes from Europe and particularly a batch of material from South America, which gives a much clearer idea of the more primitive members of the tribe. Following McDunnough I exclude the *Heliothids*, which will probably make a good tribe, though my belief is that the connection between *Rhodophora* and *Agrotis* is not a distant one. As to the *Copablepharon* and *Agrotiphila* groups, which he excludes, I am not so sure that they should be omitted, but I lack material, and particularly the material from the old world, which is needed for their real understanding. The eastern palaearctic and old world tropics have been omitted from lack of material. The only American genus I have added is *Manruta*, on Benjamin's suggestion. It proves to be a true *Agrotine*, related to *Eucoptocnemis* and the South American *Tripseuxoa*.

Several genera with hairy eyes might be brought in question. *Trichosilia* and some species of *Pachnobia* have light hair, and their other structures show plainly that they belong with *Agrotis* and the normal naked-eyes *Pachnobias*, respectively. In the case of the genera with heavily hairy eyes, there is no question that they are aberrant *Poliinae*, where their genitalia fall into place. I have kept them in the tabulation because they were included by McDunnough. Another aberrant group are *Anytus*, with its European cousin, *Cyrebis*, *Fishia* and *Ufeus*. These seem also not to be true *Agrotids*, though *Ufeus* in particular has something in common with the *Agrotis* group. I treat them as a separate group, but suspect they will eventually have to go with the "Acronyctinae."

It is assumed that McDunnough's selection of genotypes is in accordance with the rules; in two cases I have used other names where a conservanda ruling would seem to be in order; *Noctua*, already mentioned, and *Naenia*, whose type under an absolutely literal interpretation becomes the type of *Phalaena* Linnaeus.

Only a few of the South American types are included in the tabulation, but in an appendix I have attached a discussion of a number of other forms, probably sufficient to give the character of the fauna. They seem to include an interesting series of aberrant members of group II, and suggest that South America will turn out the home of the most primitive types. *Peridroma* (*Hemi-euxoa*) *polymorpha* in fact is perhaps the most primitive in genitalia yet discovered, being only challenged by *P. margaritosa* which also includes South America in its range. The new *Tripseuxoa carneata* and *Agrotis orestica* are interesting and highly aberrant reduction forms, and the other members of *Hemi-euxoa* link to *Anicla* in one way and to *Loxagrotis* in another.

Believing that we have at present no reason for assuming any one character is more important than another in this series, I have made the trial of grouping them on the basis not of single characters selected beforehand as primary, but by giving equal value to all the characters which were sharply enough defined to handle in a tabular way, hoping to find groups based on the maximum number of resemblances. This method has made a series of groups which can hardly be defined on tangible single characters, or perhaps even on manageable groups of characters, but I believe has produced an arrangement more natural than any yet attained. At least it has set off one and perhaps two groups which show tangible larval characters.

My procedure was to make up a standard list of characters for

each genus, and then determine the number of differences between *each* two genera, regardless of supposed relationship;—then I attempted to get them into a linear series so that the differences between successive genera should be as small as possible. It was found that by cleaving them first into three main groups, it was possible to arrange the contents of each group in a nearly linear fashion. These three main groups might be considered to surround *Agrotis* or *Feltia*, *Diarsia* or *Ochropleura* (*cynica* or *plecta*), and perhaps *Anomogyna* or *Aplectoides*. There were half a dozen genera which seemed to make a subgroup by themselves, though closely related to the *Anomogyna* complex, and finally a few which refused to enter the system, but stood rather equally apart from all these groups: *Anytus*, *Fishia*, *Ufeus* and *Cyrebia*; *Trichorthosia*, *Mimobarathra*, *Trichofeltia* and *Trichagrotis*.

The only North American genus that I have not studied is *Aplectoides*; Mr. Benjamin having kindly lent me from the National Museum all the others which were missing at Cornell. In most cases the genotype was studied, but in the following other species were used: *Mesembreuxoa facicola* Dyar in place of *chilensis*; *Loragrotis acclivis* in place of *proclivis*; *Eucoptocnemis tripars* in place of *fimbriaris* (a mere subspecies); *Spaelotis clandestina* in place of *ravida*; *Epipsilia grisescens* for *latens*; *Chersotis juncta* for *rectangula*; *Pachnobia okakensis* for *carnea*; *Adelphagrotis indeterminata* for *stellaris*; *Fishia exhilarata* for *entheia* (*evelina* showed some differences), and *Ufeus hulsti* for *satyricus*. For *Aplectoides* the characters were taken from McDunnough, and two small points not mentioned by him were assumed to be normal.

The following characters were tabulated:

Eyes: naked or hairy (the rudimentary hair of *Trichosilia* got half a count).

—: lashed or not; giving half a count to forms with rudimentary lashes.

Front: 1, smooth; $1\frac{1}{2}$, slightly rough; 2, rough and rounded out; $2\frac{1}{2}$, traces of a ring; 3, a raised ring. (The double ring of *Proragrotis* was not distinguished).

Male antenna: 1, simple, shortly ciliate, $1\frac{1}{2}$, suberrate and fasciculate; 2, strongly serrate (*Euxoa*); $2\frac{1}{2}$, narrowly pectinate (*ypsilon*); 3, plumose (*monochromatea*).

Vestiture: forked, simple and mixed were each considered separated by one count; intermediate types sometimes got a half-count, but the different degrees of mixed vestiture were not separated.

Thoracic tufting: present or absent; very weak or vague tufting being given half a count.

Fore tibia: 1, unarmed; $1\frac{1}{2}$, a few rudimentary spines; 2, spines about $\frac{1}{8}$ or $\frac{1}{6}$ length of tibia and not very stout; $2\frac{1}{2}$, spines $\frac{1}{4}$ or $\frac{1}{3}$ length of tibia; 3, a claw half the length of the tibia or very massive.

Mid and hind metatarsi: upper spines present or absent; if only one or two spines were present or the middle or hind tibiae were unarmed a half-count was given.

Male genitalia—Uncus: heavily tufted, densely hairy or with sparse loose hair only (half a count to each).

Corona: 1, absent, 2, diffuse, 3, regular, near margin; 4, double, with both diffuse and regular portions.

Clavus: present or absent. The clavus may possibly have been overlooked in a few forms where the sacculus is overdeveloped. A weak spine-tuft in the position of the clavus was not counted, unless it formed a definite separate organ.

Clasper: absent, simple and longitudinal, simple and more or less transverse, and forked, were each counted as one degree apart from each other, and intermediate stages were given half-counts. Note that the dorsal arm of the so-called forked clasper is morphologically the ampulla, and that the ventral arm, or true clasper, migrates to the lower edge of the valve, and then out, becoming the pollex. This structure was counted as a rudimentary lower arm of a forked clasper in *Ochropleura*, but was treated as a separate organ in such forms as *Noctua* (*Graphiphora*) even when the chitization supporting it was still preserved.

Costal chitization: a specialized chitization ending abruptly at the base of the clasper was made one count different from a simple costa; a vague chitization without definite end was given half a count.

Costal process: a definite specialization of the costal edge got one count, a mere bend was not counted.

Pollex: present or absent. See note on clasper.

Digitus: present or absent.

Sacculus: a specialized process attached to the sacculus was given one count; a mere enlarged sacculus got half a count only when strikingly developed. The curious asymmetrical structure of *Protexarnis* was also given a half-count.

Hadenid neck: an abrupt narrowing of the valve beyond the clasper, suggesting the form of "*Hadena*" or "*Mamestra*." One count.

Ædoeagus: unarmed, with one spine, multiple spines, two spines or scobinate patch were each given one count from each other. A rudimentary spine, as in many *Euxoas*, got

half a count. A scobinate patch was not counted in presence of a well developed spine.

Juxta: simple, with terminal spine, or with a square process were given one count from each other; the rounded process of *Noctua* (*Graphiphora*) was counted as half a square process. An attempt was made to tabulate the shape of the juxta but it was often too indefinite to handle.

Several other characters might have been used. The palpus shows some marked differences of type, but they were too ill-defined to be readily tabulated, and the most striking of them (the presence of long hair) correlated with the hairy thorax and merely reënforced that character. My material was not all good enough to be sure of the shape of the abdomen, which is probably a significant character, especially in subdividing the third group. Characters limited to a single genus were not tabulated, and so the relationship shown by the table should often be taken to represent not the genus as it is, but its presumable ancestor lacking its present *unique* specializations. This applies for instance to the pyramidal thoracic tuft and fore tarsal spines of *Richia*, the fantastic front of *Proragrotis*, and the uncus of *Lampra*. Such characters may perhaps be important for delimiting a genus, but give no light on the interrelationships. In general, I believe they are modern, and may even fail when other species of the genus are studied.

The chart will present the resulting relationships. Each square represents the relation between the genus named at the end of its line, and the one at the end of its column. *E.g.*, the solid black square where the fifth line and third column meet indicates that the genera *Onychagrotis* and *Mesembreuxia* differ by not more than three characters. The arrangement is such that genera which come next to each other in order will have their correlations shown near the diagonal margin of the chart, the actual last row of squares representing the relations between successive genera. I have used dark symbols for small differences and pale ones for large differences, so that a glance will show from the massing of dark areas toward the diagonal, that the arrangement is not too far from correct.

The three large groups and two small ones are separated by heavy lines, and the largest is divided into two subgroups, marked by a broken line. The arrangement may be considered almost strictly linear within each group (or subgroup) but the aberrant genera have been placed at the ends of the groups, so that the correlations between the terminal members of adjacent groups are not high.

One may also pick out the types that are synthetic in character by running along the lines, and seeing where there is an unusually high per cent of dark symbols. For instance, if we run along the lines, we find *Naenia* and *Cryptocala* show a massing of the solid black and the small white squares; they therefore differ by six characters or less from an unusually large number of genera in the third group, and so may be considered to represent the central forms of that group. On the other hand we find that *Protexarnis* has very few such symbols, and these few widely scattered; it therefore is an isolated form,—perhaps a primitive relict, that has gone off sideways. The heavy mass of dark in the group III indicates that a large number of the nominal genera here are very closely related, while the more scattered pattern in group II indicate a less homogeneous lot, that are no doubt older, for it is very generally believed that large numbers of groups with few species per group are a sign of age and partial extinction.

If we take a difference of not more than six characters as being generally allowable within a genus, we will be led to admit approximately the following genera:

In group I, *Chorizagrotis* through to *Trichosilia* are obviously very closely related, and may be fairly rated as subgenera, but *Eucroptocnemis* and *Manruta* obviously stand out from all the preceding and somewhat from each other, and should no doubt be kept as good genera, or combined with *Tripseuxoa* and each other.

In group II, *Pareuxoa lineifera* stands entirely by itself. It certainly has little or nothing to do with true *Euxoa*, which is a homogeneous enough type, and so I am giving it a distinctive generic name. *Stenagrotis*, which is unknown to me, may be related. There is no obvious reason for making a smaller or larger number of genera out of the remainder. *Ochropleura* is central and shows close links to all, even to the preceding and following groups, but the rudimentary lower fork of the clasper is most nearly matched in *Protogygia*. *Euagrotis* is very close to *Anicla*, and both are connected closely to *Hemieuxoa* by South American species discussed in the appendix. *Hemieuxoa*, *Peridroma* and *Diarsia* make another group, marked, for instance, by the Hadenid neck and more normally forked clasper. *Pseudorthosia*, *Richia*, *Pseudoglaea* and *Mesogona* have the best claim for generic status.

The group as a whole is interesting in distribution, having a most primitive South American group, with *Peridroma*, *Hemieuxoa* and *Anicla*; the holaretic *Diarsia*, perhaps a little more at home in Europe than North America, the wide-spread *Ochropleura*, palae-

arctic *Mesogona*, and endemic North American *Richia* and *Pseudoglaea*. *P. margaritosa*, perhaps the most primitive of all, is now world-wide, though possibly most at home in South America, as the Chilean segregate, *P. semifusca*, would hint.

While group II is heterogeneous, and the difficulty is to decide what groups to combine, group III is extremely homogeneous, and the trouble is where to make a cleavage at all; in fact, except for a few aberrant types there is a temptation to leave groups III and IV undivided. *Protexarnis* may be set aside at the start, it really deserves a group to itself, and shows several primitive characters more normal in group II, such as the digitus, double clasper and bearded uncus; it is certainly a relict. *Ammonoconia* is also a little aberrant, but the rest can at most be divided into two lots, with a good deal of embarrassment in drawing the boundary. I have drawn the chart on the assumption that *Lycophotia* to *Hiptelia* make one genus, and *Pseudoseptis* to *Setagrotis* another, but the two are massively connected, and even group IV joins on through *Pachnobia* and *Hiptelia*. Traditionally this series is cleaved by the presence or absence of spines on the fore tibia, but *Noctua baja* gives warning of the danger, as it is intermediate alike in tibial spining, appearance, and even in caterpillar. For the caterpillar resembles *Rhynchagrotis barnesi* even in habits, being a notorious climbing cutworm; and other species of *Noctua* also are identical with *Rhynchagrotis* even in markings.

The yellow-winged European genera all come in this group (except *Cyrebia*, which is not a true Agrotid), but they are not at all close to each other, *Triphaena* (*promuba*) going definitely with *Noctua*, while the other three group loosely about *Rhynchagrotis*. I believe the cause for these yellow Trifidae must be sought in some special past ecological factor in the Palearctic zone, and not a common origin. The fact that they are limited to the Old World, except for a few modern stragglers, is curious.

Group IV is plainly homogeneous, and hardly needs more than a single genus; in fact we might add *Hiptelia* and *Pachnobia* and reconstitute the old genus *Pachnobia* of Smith *et al.*, with very little violence. *Choephora* definitely belongs in this series, as Hampson has already placed it; but typical *Epipsilia* (*latens* and *grisescens*) stands apart, and Hampson's name cannot be used.

Trichosilia has already been placed in group I, where it makes just about a good subgenus, and the hairy-eyed *Pachnobias* are certainly not to be separated from *okakensis*; but I believe the remainder are not true Agrotines. The four genera with dense hair

(*Trichorthosia*, *Mimobarathra*, *Trichofeltia* and *Trichagrotis*) have some very distinctive characters, which reappear in the *Poliinae*, and no doubt that is where they belong. I believe now that *Trichorthosia* and *Trichagrotis* are mere variants of *Eriopyga*, to which their pattern also connects them, but *Mimobarathra* comes closer to *Barathra* itself, and *Trichofeltia* has no immediately obvious connection. Perhaps a fuller study of the hairy-eyed series will put these genera in their proper places. The male of *Trichagrotis* is of course unknown, but the female only differs in the spining of the fore tibia from *Trichorthosia*, and the pattern is identical. McDunnough's figure of *Trichorthosia* is incomplete; in fact the form has a triangular sacculus and exaggerated Hadenid neck, its genitalia being of a perfectly normal "Poliine" type (fig. 10).

The *Anytus* group are also wholly outside the *Agrotine* series, and will no doubt take their place when the "*Acronyctinae*" are analyzed. *Anytus* and *Fishia* certainly have something in common; *Cyrebis* has the *socii* of *Anytus* exaggerated, but *Ufeus* will probably attach to another group of *Acronyctinae*.

The generic list then may run somewhat as follows:

GROUP I

Agrotis (with *Chorizagrotis*, *Euxoa*, *Mesembreuxoa*, *Feltia*, *Onychagrotis*, *Proragrotis*, *Loragrotis* and perhaps *Trichosilia*)
Eucoptocnemis (with *Tripseuxoa* and *Manruta*)

GROUP II

Pareuxoa ("Euxoa" *lineifera*)
Pseudorthosia
Richia
Pseudoglaea
Ochropleura (with *Protogygia*?)
Mesogona
Anicla (with *Euagrotis*)
Peridroma (with *Hemieuxoa* and *Diarsia*)

GROUP III

Protexarnis
Noctua (with *Lycophotia*, *Heptagrotis*, *Eugraphe*, *Caradrina*, *Chersotis*, *Epipsilia*, *Triphaena*, *Graphiphora*, *Pachnobia* and *Hiptelia*)
Ammoconia
Eurois (with *Pseudoseptis*, *Actebia*, *Naenia*, *Anaplectoides*, *Hemigraphiphora*, *Eueretagrotis*, *Anomogyna*, *Spaelotis*, *Aplectoides*, *Lampra*, *Euschesis*, *Pronoctua*, *Rhynchagrotis*,

Cryptocala, Abagrotis, Protolampra, Adelphagrotis, Pseudospaelotis and *Setagrotis*)

GROUP IV

Cerastis (with *Metalepsis, Sora, Choephora, Paradiarsia* and *Hemipachnobia*)

GROUP V (not Agrotine)

Trichorthosia (with *Trichagrotis*?)

Mimobarathra

Trichofeltia

GROUP VI (not Agrotine)

Anytus, Fishia, Ufeus, Cyrebia, etc.

In the following definitions of the groups, the word "usually" must be taken as applied to every character, as no one character seems stable in any case, unless the presence of dense hair on the eyes in group V.

Group I: Front modified, antennae subserrate and fasciculate to pectinate, vestiture mixed, fore tibia with strong spines or terminal claws, mid and hind tarsi with upper spines; valve with normal corona, clasper longitudinal (or a little oblique) or forked; costa normally thickened, the thickening ending abruptly at the clasper, but not irregular in shape; juxta unarmed, uncus heavily bearded and clavus often present. Larva so far as known rough-skinned.

The chief exceptions are: front smooth in *Eucoptocnemis*, which has the strongest tibial claws of all; antenna most nearly simple in *Chorizagrotis, Loxagrotis* and *Proragrotis*; vestiture hairy in *Manruta* and a few *Euxoas* (*bostoniensis*); costal chitination absent in *Proragrotis* and *Eucoptocnemis*, and weak in a few others; uncus not tufted in *Proragrotis* and weakly in *Loxagrotis* and *Manruta*.

Group II: Front smooth; antenna subserrate and fasciculate, or usually simple, vestiture mixed, fore tibia with moderate spining, hind tarsus without upper spines; genitalia with corona present, clasper usually longitudinal or divided, juxta frequently with a spine; uncus normally tufted and clavus normally present; digitus often present; hadenid neck frequent.

The chief exceptions are: front very rough and prominent in *Pseudorthosia*, with raised ring in *Pareuxoa*, rough in *Mesogona* and *Protogygia*; antenna almost pectinate in *Pareuxoa*; vestiture hairy in *Pseudorthosia* and *Pseudoglaea* and mostly hairy in a few others; hind tarsus with upper spines in *Richia* and *Pseudorthosia*, but fore tibia un-

armed in *Pseudoglaea*; corona absent in *Pseudorthosia* and *Pareuxoa*.

Group III: Front smooth, antenna simple or fasciculate; vestiture mixed; fore tibial and hind tarsal spining variable; corona rudimentary or absent; lower fork of clasper frequently developed as a pollex, never normally developed; Sacculus more or less inflated, frequently modified more or less uncus with rudimentary tufting or none.

The chief exceptions are front a little rough in *Caradrina*, antenna pectinate in *Hiptelia*, some species of *Noctua*, *Anomogyna*, etc., vestiture hairy in *Pachnobia* and nearly so in *Hiptelia*; a diffuse corona in *Noctua* and *Ammoconia*, tuft on uncus strong in *Ammoconia*, *Actebia*, and a few of the last subgenera, also apparently in *Aplectoides*; clavus present in *Eurois* only.

Group IV: Eyes always lashed, though often feebly; front smooth; antenna serrate or pectinate, weakly only in *Cerastis*; vestiture wholly or almost wholly of hair, often with a few flattened hairs and rarely with scattered spatulate hairs; corona absent; clasper longitudinal or oblique, rarely very weak; juxta often with a spine; tuft on uncus weak or absent, and spines on fore tibia never strong, often absent; clavus absent.

Group V: Eyes strongly hairy and more or less lashed; front smooth, antenna subserrate to pectinate; fore tibia with rudimentary spines or none, and hind tarsus without upper spines; corona present, sometimes rudimentary, digitus present, heavily chitinized, and associated at base with clasper (perhaps a homologue of the true clasper rather than a real digitus); penis with numerous separate spines.

If we ignore the numerous exceptions we may key the groups as follows:

1. Eyes strongly hairy, digitus associated with clasper; penis with numerous spines Group V
 Eyes naked or with rudimentary hair, digitus well separated when present; penis with a single spine or scobinate patch...2
2. Corona normal, uncus tufted, clavus present 3
 Corona absent, uncus with scattered hair, clavus absent 4
3. Front rough or modified, antenna serrate or pectinate, fore tibia with strong armature; hind tarsus with upper spines.
 Group I
 Front smooth, antenna simple, fore tibia weakly spined and hind tarsus without upper spines Group II
4. Vestiture hairy, antenna pectinated Group IV
 Vestiture mixed, antenna simple Group III

REMARKS ON CERTAIN GENERA AND SPECIES

Chorizagrotis. This genus has no really significant difference from *Euxoa*, even the clasper differing only in proportions, not at all in type. *Protexarnis balinitis*, which Smith put in *Chorizagrotis*, and McDunnough put immediately after, is really highly aberrant. Its digitus points to group II, the inflated sacculus more definitely to group III, of which it is perhaps an aberrant member.

Mesembreuxoa. Practically a synonym of *Agrotis*. A well-marked group of Agrotini in South America, apparently distinct in origin from the primitive forms in group II. The transverse ridge on the front, used by Hampson to define the genus is meaningless, like the vertical ridge which he reports for *Feltia*.

Loxagrotis seems the most generalized member of group I. There would seem to be a real connection with *Protopgygia* of group II and to the South American *Hemieuxoas*. This is the main part of the genus which Smith called *Rhizagrotis*.

Trichosilia is hardly distinct from *Loxagrotis*. The hair on the eyes is weak, and similar to that in *Pachnobia*.

Eucoptocnemis seems as isolated on full study as it has always been. The smooth front is unique in the *Agrotis* series, to which the genitalic characters attach it safely. The fossorial tibia is only matched in the Heliothids, but other characters are entirely different, and I think it is merely a case of parallelism. The only relatives of *Eucoptocnemis* are *Manruta*, which has the same fossorial tibia and weak tongue, and looks a little like *Eucoptocnemis*, but differs clearly enough in the rough front, hairy vestiture, obsolescent corona, etc., and the South American *Tripseuxoa*, which is intermediate, but side-specialized.

Pareuxoa lineifera has nothing in common with the real species of *Euxoa*, and no doubt its fossorial fore leg and modified front are a parallel adaptation for emergence from sun-baked desert soil, such as occurs in many other groups. Leaving these out of account, the affinities are plainly with group II, but there is a beautiful composite of primitive and side-specialized characters. I believe it represents a group that arrived early in South America before the two big modern groups of Agrotini were formed, and has survived and multiplied there. Temperate South America has a number of aberrant forms which may be related, including one or two transitional to *Hemieuxoa*.

Pseudorthosia, *Richia* and *Pseudoglaea* are plainly synthetic forms; *Richia* lies almost exactly intermediate between groups I and II, and the main reason for putting it in group II is the greater

heterogeneity of that group, which receives an aberrant form with less disturbance; *Pseudorthosia* also tends to link with groups III and IV, and is an offshoot from far down in the evolution of the tribe; the superficial special likeness of *Pseudoglaea* to *Mesogona* is hardly carried out in more important characters. My belief is that McDunnough has these genera badly misplaced, especially *Pseudoglaea*, whose genitalic characters are utterly unlike those of the *Rhynchagrotis* series. The numerous spines on the penis, however, are shared by *Eueretagrotis* alone.

Ochropleura. The peculiar rudimentary spine on the lower margin of the valve gives the clew to the pollex, as it is clearly homologous with both the lower lobe of the clasper of *Euxoa* or *Hemieuxoa*, and with the pollex of *Noctua* (*Graphiphora*). *Protopygia* also shows the same stage of development, and there is something like it in *Pseudospaelotis*, while *Euagrotis* has preserved the supporting chitinization without the free point. In this series McDunnough has an entirely different grouping, interlarding *Actebia*, *Spaelotis* and *Eurois* from my group III, and even the American members of group IV. Of these *Eurois* and *Actebia* seem really to lean to group II, but I cannot see the connection of *Metalepsis* and *Cerastis*, *Hemipachnobia* and *Paradiarsia* at all. *Ochropleura* is a peculiarly synthetic type, as the large number of close resemblances to other genera (small white squares in the table) will show, and is curiously distributed, with endemic species both in Europe and South America.

Peridroma margaritosa has the distinction of having more primitive characters or characters shared with the presumably ancestral Acronyctinae than any other species of the group (unless the South American *Hemieuxoa polymorpha*); in fact there is not a single character that I can definitely label specialized. The shape of the apex of the valve and the position of the digitus are specially Acronyctine characters. *A priori* it would be an open question whether the diffuse weak spining on the tibiae, as in *Peridroma*, or the unarmed fore tibia of *Rhynchagrotis*, etc., were primitive, but I think the fact that *Peridroma* is an isolated type, in a group largely of odd forms, while *Rhynchagrotis* is typical of a large and dominant modern group, is pretty conclusive.

Protexarnis (*Chorizagrotis balinitis*) is put by McDunnough immediately next to *Chorizagrotis*. The form of the clasper is the same, but every other character points to a wide separation from *Chorizagrotis*; in particular the digitus indicates a much more primitive form. The position at the head of group III is rather

arbitrary, but it shares more characters with members of this group than any other; its affinities are widely scattered, and presumably it represents a side-specialization from the ancestor of the group. The digitus has otherwise disappeared from group III (except for a rudiment in *Ammoconia*) but its presence in *Metalepsis*, which derives from group III, is a further indication that the group originally had it.

Group III. The order of genera in group III is more arbitrary than elsewhere in the list, and would be changed by small changes in weighting of characters. The whole group are extremely closely related, and could well be left a single genus, but the separation into a *Graphiphora* series and a *Rhynchagrotis* series appears to be natural. Some links are obvious, as between *Caradrina*, *Chersotis* and *Epipsilia*, but others may be parallelism, as between *Lycophotia* and *Heptagrotis*, in fact the peculiar type of valve would connect *Lycophotia* with *Epipsilia*.

Eugraphe is unusual, in having upper spines on the mid-metatarsus only.

Eurois shows some resemblance to groups I and II, especially in having a well developed clavus; it may be ancestral.

Actebia has the spining of the tibia stronger than usual, and suggests a connection with *Agrotis*. It has a normally smooth caterpillar, unlike group I.

Lampra fimbria has an unique reduced and malformed, trilobed uncus; otherwise it agrees with *Noctua* (*Graphiphora*). The caterpillar is the wedge-marked type of this group rather than the striped type usual in group II, but does not discriminate between the subgroups. *Lampra* has the spined fore tibia of *Noctua*, while *Triphaena* shows the unarmed tibia of *Rhynchagrotis*; they also differ in genitalia, *Triphaena* having the curious thin transverse clasper normal in the *Rhynchagrotis* series.

Pachnobia and *Hiptelia*, which is certainly very close (not Orthosid), could nearly as well, perhaps better be put in the fourth group, but *Pachnobia* seems directly connected with *Noctua* also. *Chersotis*, which contains species which have also much in common, seems to have gone off in another direction, in the extreme development of the sacculus. *Chersotis* also has lashes on the scape of the antenna (not true lashes on the front) and an unique spine on the penis.

Noctua (*Graphiphora*) has a curious development of the juxta, differing from species to species. In *c-nigrum* it is scobinate, while in *N. (Lytaea) umbrosa* it has a double spine. The caterpillars of

this genus are well known for their paired blackish subdorsal patches, but really this pattern tends to appear in any part of group III, and is striking, *e.g.*, in *Triphaena*, *Lampra*, *Rhynchagrotis*, *Spaelotis*; group II tends rather to be striped.

Naenia. This is the genus which strict constructionists would make *Noctua*, or even *Phalaena*, as it contains the species named *typica* by Linnaeus. While a little exaggerated in appearance it is really very close to *triangulum*, the traditional type, so that the change would not be very violent after all. The most striking difference is the heavy tufting, but larva as well as genitalia place it in this group. It seems very close to *Anaplectoides (pressa)*.

Group IV. *Paradiarsia* and *Hemipachnobia* go together, and stand a little apart from the rest, but hardly make what would normally be called a distinct genus. If a character is wanted to separate them the presence of upper spines on the hind metatarsus will serve. *Sora* has an unique bundle of long spines in the penis, and *Cerastis* a spinose gnathos, which are unique in the tribe, but probably hardly more than specific in significance.

Group V. *Mimobarathra*. The appearance and heavy tufting suggest *Barathra*. The uncus is obsolete, fore tibial epiphysis modified and tarsus spined. The type of digitus is much more to be expected in the hairy eyed series, and the multiple spining on the penis is very rare in the Agrotini.

Trichorthosia. McDunnough's figure is incomplete (see fig. 10). The form has a widened tip of the valve with Hadenid neck and corona, and the whole thing indicates close affinity to *Eriopyga*, where the pattern is absolutely normal.

Trichagrotis. The female shows no very important differences from the preceding, and the markings are almost identical. I suspect the slightly stronger spining is not of generic value.

Trichofeltia. It is one of the mysteries how this type ever came to be confused with *Feltia*, with which it has practically nothing in common. The genitalia suggest *Trichorthosia*, but are much more specialized, and no doubt it will find its place when the hairy-eyed groups are properly studied.

PHYLOGENY

An attempt was made to select the most probable ancestor of the group by making out a list of characters that were either obviously primitive, or common to some Agrotini and many Acronyctinae. Where there was doubt an intermediate condition was chosen. When this list was compared with the characters of

the various genera it was found that *Peridroma saucia* came far nearer than any other genus, and that group II as a whole was nearer than any other group. This suggestion that group II is ancestral is confirmed by the fact it is more heterogeneous than the others, and that it has a large percent of isolated species. Evolution within the group may be indicated by the survival of the various ancestral characters of *Peridroma* in other subgenera and genera.

Hemieuxoa and *Diarsia* are obviously immediate derivatives of *Peridroma*. At the next level comes *Ochropleura*, which is apparently on another line, and from which *Protogygia* may be directly derived; *Euagrotis* and *Anicla* make another line; perhaps associated with the first. This little genealogy is perhaps as plausible as any (fig. 11).

Group I is obviously derivable from group II, and the ancestor might be something much like *Protogygia*, but with better developed clasper, more like *Peridroma* itself or *Hemieuxoa*; from this there must have arisen two main branches, one which kept the forked clasper, and the other which lost the lower branch. From some member of the latter (most probably *Onychagrotis*) arose *Manruta* and *Eucoptocnemis*, which have a good deal in common but have diverged in the front and many details. Presumably the Heliothidini, which have also the rough front and granulose caterpillar, come from the stock of group I, and it is possible that *Manruta* may represent the line of connection, though I believe that the Heliothidini arose from near typical *Agrotis*. *Heliothis* lacks the clasper, but it is perfectly well formed in *Rhodophora*.

Group III is on the whole so homogeneous that phylogeny has little meaning. *Actebia*, *Naenia*, *Pseudospaelotis* and *Setagrotis* on the whole resemble *Peridroma* in the most characters, and are no doubt primitive in their subgroups; *Anaplectoides* is also low, and shows resemblances to the widest range of genera. The mass of subgenera may be divided into a group that tend to strengthen the leg-spining and to develop a row of spines on the metatarsi (*Eurois*, etc.) and one that tend to weaken the spinning and finally lose it wholly from the fore-tibia (*Rhynchagrotis*, etc.). *Lampra* is curious in combining both tendencies, and is uniquely specialized besides, but must have some connection with *Noctua*, while the other yellow-winged genera belong to the *Rhynchagrotis* group, where each is specialized in a different way. *Pachnobia* and *Hiptelia* are directly derived from something like *Noctua*, and in turn supply the point of origin of group IV.

Group IV seems to be composed of two main subgroups, one with *Paradiarsia* and *Hemipachnobia*, the other with *Sora* and *Cerastis* as relatively primitive members, from which *Metalepsis* and *Choephora* are separately derived.

SUMMARY

The Agrotini as restricted by McDunnough may be divided into four main subgroups:

a. *Agrotis*, etc., with corona, modified front, antenna and fore legs; and rough caterpillar.

b. *Peridroma*, etc., with corona, smooth head, frequently modified genitalia and smooth generally striped caterpillar.

c. *Noctua*, etc., without corona or special body-modifications, but with a tendency to reduction; caterpillar smooth with subdorsal spots as a rule.

d. *Cerastis*, derived from c, but with hairy vestiture.

2. The second group is primitive, *Peridroma saucia* being the most primitive species; the dominant 1st and 3rd groups are separately derived from it.

3. *Cyrebia*, *Trichofeltia*, *Mimobarathra*, *Trichorthosia* and probably *Trichagrotis* are not Agrotini, besides the genera rejected by McDunnough. *Manruta* is Agrotid.

SUPPLEMENT ON SOME SOUTH AMERICAN TYPES, INCLUDING NEW NAMES

It has been assumed in the preceding that McDunnough's revision supplies most of the information necessary for the discussion of the North American forms, which have been supplemented by figures of a few European types not figured by Pierce. In the case of the South American fauna nothing has been published on their genitalia and little on their classification otherwise, so a little more detailed information is in order. The following notes include only perhaps half of the known South American Agrotids, but are sufficient to give a clear picture of the general character of the fauna. A large proportion of the remainder are represented only by specimens in the British Museum. They have not been studied with care, but their general appearance suggests that they will fall into the same groups, though they may add some further variety of structure. The most striking feature is that the third group, dominant in the northern hemisphere, seems entirely unknown from

South America, and the fourth group, which is a segregate of it, is also absent.

Generic terms are used in a more inclusive sense than by McDunnough, treating McDunnough's genera as subgenera, as discussed above.

AGROTIS Ochsenheimer

(type *Phalaena segetum* Schiff.)

Antennae varying from nearly simple to pectinate, most typically heavily serrate and fasciculate. Front rough and rounded out, except in the North Temperate race of *A. ypsilon*, and *A. geniculata*; frequently with a raised ring, which may contain unstable traces of further structures. Tongue strong. Fore tibia with heavy specialized spines supplemented with spines on the tarsus in *A. orestica*, new species; mid and hind tarsi with upper spines; uncus heavily bearded, normal; valve with corona and simple curved clasper, without digitus or pollex, or costal or dorsal modifications; clavus variable in size, sometimes minute, but never absent. Penis unarmed or with a simple small scobinate patch or a minute spine.

In this conception I include *Feltia* and *Mesembreuxoa*, of the genera reported from the South American fauna, the frontal ridges which Hampson uses for their differentiation being inconstant accidents of development of the area within the chitinized ring. Of the genera not yet known from South America, *Loragrotis*, *Onychagrotis*, *Porosagrotis* and *Proragrotis* are very close and should probably be included; *Euxoa* with *Chorizagrotis* differs in the more complete forked clasper, but is really hardly distinct. The most convenient subdivision³ is by the male antenna, which varies from plumose (*fascicola*) to nearly simple (*orestica*); small differences in the genitalia, such as the armature of the penis, may be really more important, but the group is genitally very uniform. Only *A. orestica*, new species, is more aberrant in lacking the corona and having enlarged spines on the fore tarsus. It has the minute single cornutus of typical *Feltia*.

³ A tabulation of the species indicates that the strength of the clasper is perhaps a more important character to divide *Agrotis*. In *A. annera*, *bilitura* and *fascicola*, as well as the North American *herelis* group it is strong, while in *malefida* and *experta*, with the North American *venerabilis*, *vetusta* and *volubilis*, the wide-spread *ypsilon* and the European *segetum*, it is much weaker. *A. edmondsi* shows a very weak clasper, thus differing from *fascicola*, while *orestica* has an exceptionally strong one.

**Antenna pectinate*

A. fascicola Dyar. My specimen is compared with the type, and seems to differ only in the much better condition. It is much like *M. chilensis* but much larger. The vertical ridge on the front fails as a character, and these two species will run in Hampson's keys to *lutescens* and *araucaria*, from which they differ by the strongly developed black wedges before the s. t. line. *A. edmondsi* is really closer, but has contrasting pale veins (not white but light clay color). Male genitalia (fig. 1) with clasper larger in proportion to the valve than in the majority of species, and clavus minute. No cornuti.

A. edmondsii Butl. Closely similar to the last in pattern, except that the veins are broadly streaked with cream or clay color. Antenna hardly as broad, but broader than in *ypsilon*. Genitalia with short clasper (fig. 2), slenderer valve than usual and obsolete clavus. Penis with a small scobinate patch as in *A. segetum*, *experta*, etc.

A. edmondsii Butl. Closely similar to the last in pattern, except in all its forms by the small black wedge at the outer side of the reniform. Otherwise some specimens may show a remarkable resemblance to *annexa*, even with traces of its sexual dimorphism. Chilean specimens (*A. y. robusta* Blanch.) are very large and pale and have a strongly roughened and rounded front, while northern specimens, unlike most species of *Agrotis*, are smooth. The form from Lima, Perú, is normal in pattern and coloring, but shows traces of the rough front. Male genitalia similar in Europe, North America and Chile; figured by Pierce, Genitalia of British Noctuidae, Pl. 16, under the name of *suffusa*. Clavus small but distinct, clasper small, as in *edmondsii*; penis with scobinate patch.

Hampson puts *A. araucaria*, *coquimbensis* and *americana* in this group. None of these are at hand.

***Antennae strongly serrate and fasciculate*

A. annexa Treit. The antennal serrations in this species are very strong, and the female is strikingly darker than the male; the relationship with *ypsilon* is certainly close. My specimens from Lima vary widely. The largest agrees with my notes on *lutescens* in the B. M., being large, with a heavy blackish shade below the base of the cell, and another from the end of the cell to the st. line. A small specimen (fig. 15) on the other hand has no traces of the two shades but only a slight basal dash and a very slender bar be-

tween the orbicular and reniform, which are small but strikingly outlined with black. Others are intermediate and much like North American males. The female associated with *lutescens* in the B. M. is much paler than others and not much darker than the male.⁴ Male genitalia (fig. 14) with medium sized clasper, a little larger in proportion in the pauperized specimen (fig. 15), apex of valve a little extended costally but less than in *malefida*, strong slender clavus and unarmed penis.⁵

A. malefida Guen. This is one of the few *Agrotids* that are found in the Brazilian subregion, but apparently is less at home there than *margaritosa* and especially *infecta*. My male from Lima is paler and more crisply marked than normal ones and the females are much darker with obsolescent markings. The male resembles *A. canities*, but differs in having distinct subterminal black dashes between the veins, and (perhaps not always) in the solid black claviform. The female is hardly distinguishable from the blackish female of *experta*, which is common also at Lima, but *malefida* can generally be separated by the t. a. line, which loops out more than half way to the t. p. below vein A. The genitalia of *A. malefida* (fig. 17) seem indistinguishable from *experta*.

A. experta Wlk. This is the common *Agrotis* at Lima, my specimens being taken at street lights in the city at the beginning of the rainy (or rather misty) season; May 15-21, 1920. The type were from Callao, only 7 miles away. This species is distinguished latter extremely variable in form, from a small circle to a long by its plainness; the ren. and orb. usually dark smudges, but the fusiform shape connecting with the ren. Specimens of both show the same genitalia. It agrees with *malefida* in genitalia, and in most pattern features, except for the vagueness of all markings, and with the local strain of *malefida* also in the sexual dimorphism, the female being blackish and the male light ash gray. It differs in the t. a. line, which is not strongly waved and not specially extended

⁴ Note that by some accident Hampson entered *lutescens* twice, as an independent species of *Euxoa*, and as a synonym of *annexa*.

⁵ Just here there is some tendency to preserve the digitus, as in the North American genus *Richia*, which may be related. In one specimen of *annexa* from Lima agreeing with form *lutescens*, there is a distinct trace as a chitinated prominence; another pauperized specimen does not show a trace. In a North American specimen there is a just traceable rudiment, while in a closely related, but apparently undescribed species from the Argentine the digitus is well formed (fig. 16).

below the cell. The genitalia (fig. 5) are as in *malefida*, with the apex strongly extended costally, moderate clasper, and small scobinate patch on the penis,

A. canities Hamp. (Grote ms.) was examined superficially at the British Museum. It differs from both these species in having no trace of subterminal black dashes, otherwise it might be a form of either, showing the general lack of contrasts of *experta*, with the course of the t. a. line of *malefida*. The ren. was round, but the Lima series of *experta* throws suspicion on this character.

A. bilitura Guen. This species shows remarkably little really describable to separate it from *annexa*. The antenna is perhaps a little less serrate, the moth larger and heavier, not sexually dimorphic, but with identical markings. The best difference is perhaps the terminal area, which is luteous in *annexa* (concolorous with the lower median area in the male, but contrasting in the female) while in *bilitura* it is concolorous fuscous in both sexes. My specimens are from Lima, Perú, the types were from Chile. The male genitalia (fig. 6) have broader and more massive valves than the other species; clasper medium, clavus very strong and penis unarmed. "*Euxoa*" *hispidula* Guen. was not examined, it must be very close.

*** *Antennae simple, fasciculate*

A. orestica new species. Male antennae simple, but heavily bifasciculate; front rough and rounded out, with a diffuse ring; eyes naked, with rudimentary lashes; thorax with mixed vestiture, largely spatulate, with rather divided tufts; palpus with second segment widened to end, but not really clavate. Fore tibia with moderate spines, mid and hind tarsi with subdorsal series of spines; tarsal spines as a whole rather stronger than usual, especially on outer side of fore metatarsus. Male genitalia (fig. 20) with outer part of valve aborted, without corona, clasper large and simple, longitudinal, costa with abrupt end to thickening, no special modifications; uncus broad and heavily bearded; juxta simple, clavus very large; penis with heavily chitinized margin and both a minute spine and diffuse scobinate patch.

Dull fuscous. Head blackish, with lower face fuscous; palpi blackish, with luteous hair-scales on lower edge and tip of second segment, and luteous inner face; antenna with contrasting cream scape; shaft above annulate with luteous and blackish, the base nearly solid blackish, and outer part becoming mainly luteous. Thorax with basal half of collar black, contrasting, the rest frosted with fine white scale-

tips. Abdomen lighter, and with a little warmer yellowish or buffy tint above. Fore wing mostly vaguely shaded, costa paler down to below cell toward base, defined below by a diffuse but contrasting black basal dash; subapically also blackish, ending abruptly at the position of the st. line; a faint darker t. shading opposite cell. B. l. a conspicuous double blackish stria at costal edge, and showing again as a contrasting luteous oblique bar across the basal dash; t. a. also showing as a double costal stria and oblique bar across tip of basal dash; the basal line oblique in, the t. a. oblique out. T. a. also faintly traceable the rest of the way, waved, and extended out below A. Claviform obsolete; orb. a pale V, open widely to costa; ren. a vague pale shade, a little more defined on its inner side; t. p. and st. pale, defined with dark, only visible in a favorable light; the t. p. excurved moderately, most strongly over M_2 and M_3 ; abruptly offset far in at costa, on lower half of wing lunulate, with two lunules in fold; st. extended half way to margin opposite cell, dentate below. A fine faint broken blackish t. line. Fringe with three paler and darker fuscous stripes, the extreme base palest. Hind wing translucent white, with a little infuscation on margin, on veins toward margin, and especially on the long hair at inner margin. Expanse 40 mm.

Matucana, Perú, on west slope of the Andes; June 16, 1914. H. S. Parish; type male in Cornell University collection and one paratype, type no. 1242.

This species may go in the subgenus *Porosagrotis* but is distinguished by the loss of the corona. I do not know any other species that belongs with it; they may be found in Hampson's last group of *Euxoa* (e.g., *cleiducha*) or *Feltia* (*clerica*).

EUXOA Hübner (*Carneades* Grote)

(type *nivens* Hübner)

Similar to *Agrotis*. Clasper deeply bifurcate.

I have no authentic record of the occurrence of this genus (in the sense of Grote, Smith, McDunnough and North American workers generally) in South America, though I have a single female from Oroya, Perú, that appears to belong to it. Most of the Hampson species examined belong to typical *Agrotis*,—in fact, he even includes *segetum*, the type of *Agrotis*, in *Euxoa*. *E. lineifera* is a very distinct type, and does not even belong to this group. Several species have not been examined for genitalic characters, and where not very close to known species cannot therefore be placed.

TRIPSEUXOA Hampson

(type *T. strigata* Hampson)

Showing the principal characters of group I. Tongue weak, front rough and rounded out; eyes naked with rudimentary lashes; antenna pectinate; vestiture fine but mixed with hair and flattened hair; tarsi without upper spines, fore tibiae spined. Thorax smooth. Male genitalia (fig. 21) without corona, clasper simple, oblique; no other modifications. Uncus bearded (modified). The genus is distinct enough to be kept separate from *Agrotis*, but could be legitimately treated as a subgenus of the North American *Eucoptocnemis*, with *Manruta*. The differences are numerous but not important, the chief being the weaker spining of the fore tibia as reported by Hampson (lost in my species) and loss of the corona. The latter character is paralleled by the preceding species of *Agrotis*, and in both cases accompanies a reduction of the whole end of the valve (unlike the *Noctua* group). *Eucoptocnemis* and *Manruta* also have a reduced corona, though it is recognizable.

T. carneata new species,

Light flesh color. Head and thorax dulled by fine white and blackish dusting. Palpi hairy, regularly tapering toward tip of second joint, blackish on outer side. Fore wing with the flesh tint intensified toward margins, very lightly flecked with scattered fuscous scales. Ordinary lines absent, all markings being of spots. T. a. represented by obscure dashes on Cu and A; orb a dot; ren. a vertical bar, with a suggestion of division into two thick spots; t. p. a series of dots, parallel to outer margin; five of the dots (R_5 and M_1 , M_3 and Cu_1 , A) stronger, and those above R_5 absent. Outer margin with a little more blackish dusting, but no t. l. Hind wing white, less transparent than in most South American Agrotids, R and M_1 strongly stalked (as also in *T. strigata*, but unlike most Agrotinae). 27 mm.

Lassance, Minas, Brazil, Nov. 15, 1919, R. G. Harris. Type in coll. Cornell Univ. Type no. 1243.

This completes the first *Agrotis* group. The second seems much more characteristic of the Chilean subregion, being relatively richer there than elsewhere, and as remarked is probably more or less a group of relicts. The only principal type of the group absent from South America is the Holarctic *Diarsia*, which has the distribution of the third group and approaches it in structure. No South American *Ochropleura* is at hand, but *vibora* must certainly belong to it.

The most striking characters of the group are the preservation of the digitus and Hadenid neck, but the forms are varied, and many have lost one or the other. Where in the *Agrotis* group it is difficult to find distinctions good enough for species, in this group each species examined (outside of *Diarsia*) is almost distinct enough for a genus. For the present, *Peridroma*, which seems to be the oldest name, will be used in an inclusive sense.

Peridroma (Peridroma) margaritosa Haw. (figs. 22, 30). This is an isolated species, worthy of a subgenus, and possibly a genus. The genitalia are figured by Pierce, pl. 18 (as *saucia*), also the valve and clasper in Smith, Bull. U. S. Nat. Mus. 38, Pl. 3, fig. 29. A specimen from Lima is typical in markings and structure, but it is possible that genitalic examination may show the Chilean *P. semifusca* is distinct. *P. ochronota* is a mere color form, present also in North America. In any case the species is closer to the South American *Hemieuxoa* complex than any other, and has probably spread in modern times from South America.

The next few species would belong to *Hemieuxoa* of McDunnough, or are transitional to *Anicla*, having the appearance of *Anicla* without its unique genitalic features. The first few species have a digitus, like typical *Peridroma*, though it is very small in *H. rudens*, and was overlooked by McDunnough, while the last two, which superficially resemble *Anicla*, have also lost the digitus. *Euagrotis* McD. also belongs to this immediate group.

P. (Hemieuxoa) rudens Harv. (figs. 23, 33). This species is from North America, and is figured to show the small digitus, overlooked by McDunnough. This is the most specialized species, with the deeply forked clasper and lobed saccus. The penis has two spines. McDunnough's assumption that *rudens* and *pellucidalis* are dimorphic forms is confirmed by the presence of parallel dimorphic forms of the Lima species described below.

P. (H.) conchidia Btl. Through the kindness of Mr. Tams, I am able to figure a specimen from the British Museum, of the type lot (figs. 24, 32). The fork of the clasper is short, and terminal, the digitus is much stronger, and the lobing of the sacculus is overshadowed by a great widening of the base of the clasper. The conspicuous part of the clasper in this and the following species is the morphological equivalent of the true clasper as distinct from the ampulla, corresponding to the lower fork of the clasper in *Euxoa* and *Chorizagrotis*, and the bluntly rounded lower lobe in *Peridroma* proper, in *rudens* and *microstigma* it is the ampulla. Penis with 2 spines. I have seen only the type lot of this species, which resem-

bles the following remarkably in superficial characters. No specimens with black in the cell are known.

P. (H.) polymorpha new species.

Closely similar to *P. (H.) conchidia*, but duller, and without the yellowish shading beyond the cell and in the sub-medial region, etc. Dull fuscous, with scattered black scales, and faintly mottled in lighter and darker shades. Head and thorax concolorous but heavily frosted with fine white scale-tips. Antennae with shaft darker and scape paler. Fore wing with the veins a little brownish, and more flecked with black and white, but not at all contrasting. Ordinary lines double, blackish, waved and interrupted on veins, varying from distinct to practically obsolete. Basal line of lunules at costa and below cell, apparently less oblique than in *conchidia*; antemedial regularly waved; post-medial sinuous out beyond cell and concave below, normal, usually very faint; subterminal irregular, pale and interrupted, sometimes obsolete; with a dark shade at costa before it, and with more or less of a dark shade opposite cell beyond, sometimes just crossing the line, and often obsolete; t. sp. sometimes more diffusely dark, or with a separate weaker dark shade at anal angle. T. line black, broken into dots between veins, and a gray line in fringe broken into dots opposite veins. Orb. small, round, dark gray, sometimes contrasting, encircled with luteous mixed with bright buff scales, and then with blackish, reniform similar, blunt kidney-shaped, extended at lower angle, usually similarly outlined except at the lower outer extension, which is plain. Hind wing translucent white; shaded broadly toward margin with light fuscous, and with light fuscous veins. 28-33 mm.

The species is highly variable and shows the same dimorphism as *H. rudens*. In two specimens the tegulae and costal portion of the fore wing are heavily infuscated except for the pale apex, as in *P. margaritosa* f. *ochronota*; in two there is a slender black basal dash and bar connecting the orb. and ren. along the lower edge of the cell, and a narrow black stripe on the collar, in one the basal dash is heavy, the black in the cell takes the form of thick spots both before the orb. and beyond it, and the bar on the collar is heavy. This last corresponds to the *rudens* form of *H. rudens*. In this specimen the usual transverse markings are almost lost.

Male genitalia (figs. 23, 31) substantially smaller in proportion to the size of the moth than in the other species examined; uncus with a little double tuft of terminal spines; valve with hadenid neck

strong, much broadened at the end with corona of only about 8 spines toward its costal side; lobe of sacculus rounded over, not prominent; clasper extremely modified, the costal lobe (the one which is forked in *rudens*) reduced to a short blunt prong, but the dorsal one much enlarged and scoop-shaped, with concavely truncate end; digitus weak, though larger than in *rudens*, and overlapping costal edge of valve; juxta unarmed, penis with a single strong spine. The lower prong of the clasper is usually visible without dissection and identifies the species immediately.

Desert side of western Perú. Type male from Lima, May 14, 1920, at light in city, in coll. Cornell Univ., type no. 1244; paratypes from same lot and till May 21; also from Chosica, May 25, and Matucana, May 12; the specimen with dark costa was taken at Lima, May 19, the two forms with black in the cell also at Lima, May 20. This is the commonest agrotid moth of the area, and we also have it from H. S. Parish, collected at Lima in 1914.

P. (H.) microstigma Schs. This species has been seen only in the fully marked *rudens*-like form. The male genitalia (figs. 26, 34) are again quite unlike the other species in the form of the clasper, the upper lobe being slender, oblique and simple, and the lower represented only by a bluntly pointed extension of the whole clasper; sacculus with a hairy lobe on its *dorsal* edge; corona nearly lost, the hadenid neck nearly lost, and dorsal lobing in the sacculus completely smoothed out, digitus very large, nearly reaching tip of valve, uncus long and slender, and penis with four spines.

P. (H.?) messia Guen. This species, which superficially can hardly be separated from *infecta*, is entirely different in details of genitalia (figs. 27, 35), in fact is as close to *Hemieuxoa* as to *Anicla*. The little tuft of spines on the tip of the uncus suggest *Hemieuxoa* and the hadenid neck is well formed, but the digitus is absent, being replaced by a slight chitinization on the surface of the valve, which is found in various other forms; the clasper has a single free end, somewhat scoop-shaped and truncate, but from its attachment obviously distinct from the larger scoop of *H. polymorpha*. Penis with three spines. This species differs from *Anicla infecta* among other things, in the normal uncus, normally proportioned valve, with much stronger clasper, absence of the lobe on sacculus and loss of the clavus. In all but the last of these *infecta* is more specialized.

I have another species received as *ferruginescens*, which is probably correct, but lacks the black bar on the collar used by Hampson as a key character. Its genitalia are substantially as in

messia (figs. 28, 36), but the clasper is simpler and the corona weaker.

P. (Anicla) infecta Ochs. Separate from all the preceding by the enormously exaggerated uncus and valves, but more primitive in preserving the clasper. The resemblance to *Euagrotis*, which is apparently purely North American, suggests that this species also may have originated in North America. South American specimens seem on the average less gray than northern ones, but the difference is only statistical, and there is no difference in the genitalia, which are figured by McDunnough, p. 42.

PSAPHARA Walker

Hampson sinks this genus to *Epipsilia*, a member of the third main group of Agrotinae. As McDunnough notes (p. 13) it has nothing in common with any of the northern types included in this conception,—it fact it belongs to group 2. It has a corona, hadenid neck, modified uncus, much as in *P. margaritosa* and *P. (Anicla) infecta*, and oblique clasper. The fore tibia is figured as simply spined (now missing from the type), tarsi with no upper row of spines, and antennae plumose. *P. coppingeri*, which is placed next to it by Hampson, is closely related, it seems, but the type has lost its legs; and it is likely that many or all the remaining South American "*Epipsilias*" will belong here. It is a distinct subgenus of *Peridroma* or perhaps a distinct genus.

Pareuxoa new genus

(type *Noctua lineifera* Blanch.)

Superficially with the structures of *Euxoa*, to the extent of having a raised ring on the front and serrate and fasciculate antennae, but entirely different in appearance and genitalic characters, in the latter definitely belonging to the second and not the first group of Agrotids.

Eyes naked, with rudimentary lashes; front with a raised ring; antenna heavily biserrate and fasciculate, vestiture smooth, hairy with a little flattened hair intermixed (unlike any true *Euxoa* known to me, the nearest being *E. bostoniensis*, which has a mass of loose fluffy hair); fore tibia strongly spined, the longest spine about $\frac{1}{4}$ as long as the tibia; mid and hind tarsi without upper spinules (unlike *Euxoa*). Male genitalia (fig 16) with corona absent and apical portion much reduced, the digitus very large and extending well toward its tip; clasper oblique with its dorsal base much swollen, costa thickened, but without abrupt end

at base of clasper; uncus flat, hairy, truncate but not modified; tegumen with peniculi projecting as small free lobes; clavus absent, juxta with a central projection ending in a group of short heavy spines.

The genus may be separated from *Euxoa* in Hampson's arrangement by the smooth hairy vestiture and lack of upper spines on the tarsi; in fact it belongs to group 2, from all the other types of which the combination of spined juxta and lack of corona will separate it. It has no close relatives known, and on a tabulation of characters seems to come closest to *Mesogona* and *Pseudorthosia*, with neither of which it has any true connection.

NOTES ON THE CLASPER

In the preceding discussion I have followed the usual custom of using the term "clasper" in a somewhat inclusive sense. The material, in fact, gives a little clue to the true morphology of this group of structures. The clasper, in the broad sense, appears to be a definite appendage, or perhaps morphologically terminal segment of the valve, as is indicated by its independent muscle (fig. 24). This muscle always originates from inside the body-cavity, and sometimes, if not always, has fascicles also arising from the base of the valve, but both sets of fibres converge and are inserted at a single point, which is typically a separate sclerite on the inner face of the valve. It would seem best to consider this sclerite the true clasper, whether it is complex, as in many Noctuidae, or as in some Pieridae, is reduced to a mere chitinous rod. In the present group the primitive form appears to be a V-shaped chitinous base, to the notch of which the muscle is attached, and which terminates in two free processes. The more ventral normally continues the line of the muscle, and is the clasper proper (stippled in the series of diagrams, figs. 30 to 37); the more costal (solid black) is attached to the costal part of this base, and extends typically obliquely up and out. In this group it is similar in character, being a simple chitinous spike or hook, but in some Noctuidae it bears a tuft of bristles. Actually this is the structure called *ampulla* by Pierce.

In the Agrotinae the two free processes are only occasionally both developed, as in *P. (Hemieuxoa) polymorpha* (fig. 31) and *Euxoa*, with *Chorizagrotis*. Occasionally the true clasper only is found (*H. conchidia*, fig. 32), but it is much commoner for the true clasper to degenerate, as shown by the fact there is no projection opposite the muscle insertion, and then the ampulla to swing out

and down, and take the function of the clasper;—in which case it commonly gets the name of clasper as well, as in *Agrotis* and several genera related to it. It is interesting to note in following through the series of *Diarsia*, *Ochropleura* and *Noctua*, that in this series the true clasper has not degenerated directly, but has moved down to the edge of the valve, and then out toward the apex. By following out the series it is clear that the organ called “pollex” in the *Noctua* group is truly the clasper, while the organ that is considered the clasper, is morphologically the ampulla. Finally in a few species, the ampulla regains its character of a transverse hairy process, as shown by various species of *Rhynchagrotis*, and *Triphaena pronuba* (Pierce, Plate 15).

Of course the line of development may be quite different in other subfamilies of the Noctuidae, some of which have a perfectly normal ampulla (e.g., *Leucania turca*, Pierce, pl. 6). The case of the hairy-eyed types is specially obscure (fig. 10), but my suspicion is that the more costal process, which has the muscular attachment is the true clasper, and the more ventral is either the ampulla which has passed under it, or more probably really the digitus.

POSTSCRIPT: Some additional material and study serves to round out certain points.

Of the forms along the boundary, *Timora* and *Adisura* are normal Heliothines, but *Copablepharon* is very close to *Agrotis*, in fact hardly a subgenus. *Actinotia* shows a general Agrotine character, but is generically distinct; it has most of the characters of *Anomogyna*; but with a well developed corona, and perhaps comes from the main stem of group 3.

A number of further forms from South America were examined and most of them go to *Hemieuxoa*, but with very strong specific characters. *H. strigata* and *lacteicosta* are normal; *strigigrapha* and *tiniloides* have lost the corona, and *mendosica* has a double uncus. All show the double cluster of spines at the tip of the uncus, like the other *Hemieuxoas*. *Ignicans* is a normal *Anicla*, but very distinct from *infecta*; while *leucanioides* is nearest *Anicla*, but aberrant. “*Episilia*” *rufisigna* turns out to be a true *Peridroma*, though of course very distinct from *margaritosa*; and still more definitely indicates South America as the home of that genus. *Agrotis trisignata* is a true *Agrotis* in the broad sense, but about equally distinct from *Mesembreuxoa*, *Feltia* and typical *Agrotis*.

Several forms from temperate Central Asia go in group 3. "*Lycophotia*" *alpestris* is a *Caradrina* in the sense of McDunnough but leaning toward *Chersotis* and *Lycophotia*. "*Epipsilia*" *junonia* is a *Chersotis*, leaning toward *Caradrina*; and *E. canescens* lies between *Graphiphora*, *Hiptelia* and *Pachnobia*, filling the very small space between them. "*Epipsilia*" *juldussi* is a more aberrant type, and comes nearest to showing the characters of *Ochropleura*. At first glance it gives the curious impression of a mixture of *Agrotis* and *Pachnobia*.

Two forms from the Australasian region are now available. *Agrotis innominata*, which Hampson transferred to *Lycophotia* for some obscure reason, is a true *Agrotis*, and not far from the typical group. *A. compta*, which would at first glance be taken for a mere variety of *Noctua baja*, turns out to be an aberrant *Diarsia*. As these two forms are fairly representative of the Agrotids from the Old World Tropics, it seems not improbable that groups 3 and 4 will be as completely absent from the Old World tropics as they are from the new. They seem to be a modern North Temperate development, which has not yet had time to reach its full possible distribution.

EXPLANATION OF FIGURES

Except where otherwise stated the figures show the male genitalia spread out in ventral view with the left valve removed, and the penis drawn separately and to the same scale. The separate figures are not to scale, except the series on the clasper (figs. 30-37). The valves are drawn as accurately as possible in flat side view, but the tegumen-rings are only partly indicated, showing the distortion resulting from mounting in most cases. The uncus is generally turned to show a side view.

PLATE I

- Fig. 1. *Mesogona acetosellae*, France
 2. *Ammonoconia caecimacula*, Vienna
 3. *Cyrebis anachoreta*, Europe
 4. *Epipsilia grisea*, Europe
 5. Genealogy of the *Agrotis* group. The vertical distance indicates roughly the degree of specialization, 3 mm., representing roughly one tabulated difference from *Protophygia*

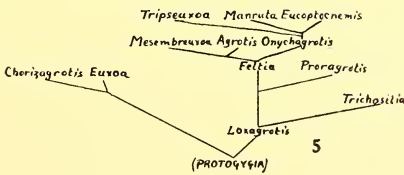
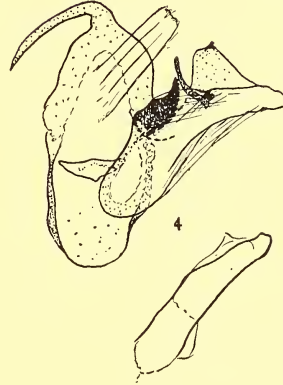
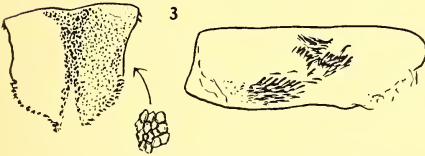
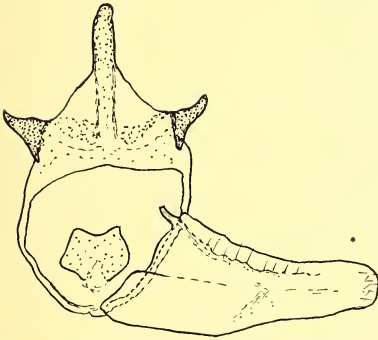
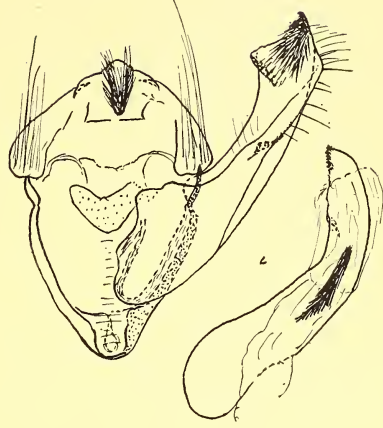
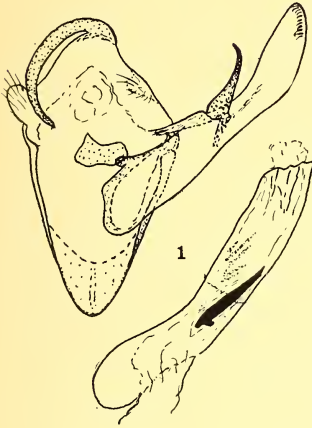


PLATE II

- Fig. 6. *Ufeus hulsti*, Truckee, Cal.
7. *Fishia evelina*, Wallace, Idaho
8. *F. exhilarata*, Miniota, Man.
9. *Hiptelia ochreago*, Europe
10. *Trichorthosia parallela*, Jemez Mts., New Mexico; valve only, showing apex and corona, missing in McDunnough's figure
11. Genealogy of group II; compare fig. 5

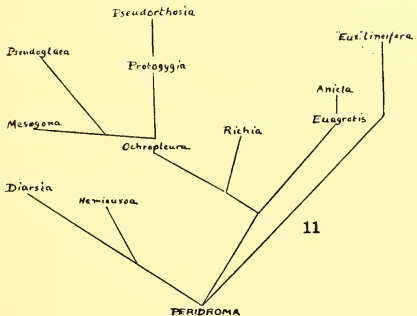
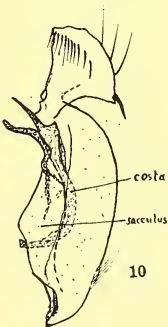
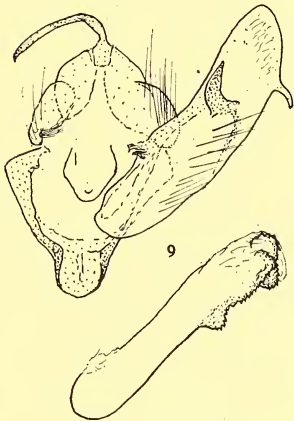
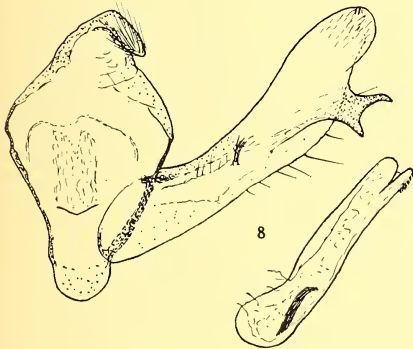
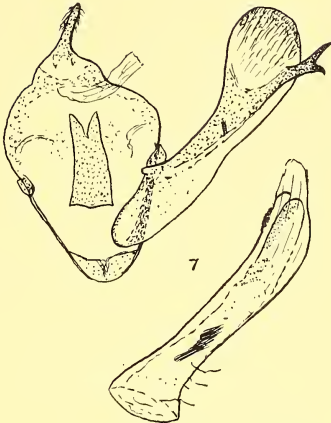
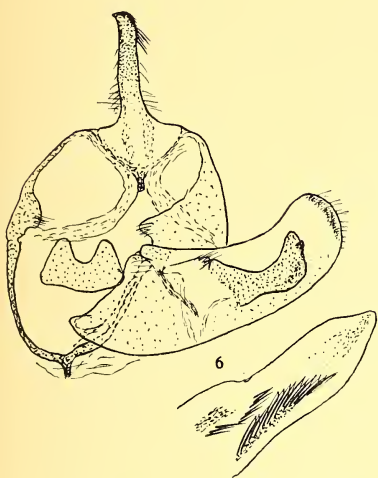


PLATE III

- Fig. 12. *Agrotis fascicola*, Lima, Perú
13. *A. edmondsii*, Valdivia, Chile
14. *A. annexa*, Lima, Perú; specimen with weak digitus
15. *A. annexa*, Lima, Perú; pauperized specimen, without digitus
16. *A.* new species, Potrerillos, Argentina (valve only)
17. *A. malefida*, Deming, New Mexico
18. *A. experta*, Lima, Perú

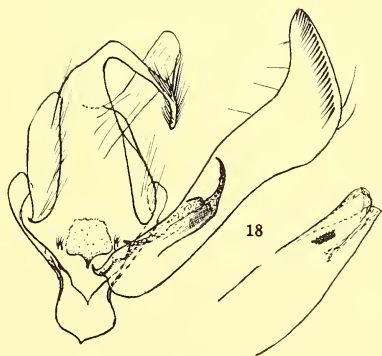
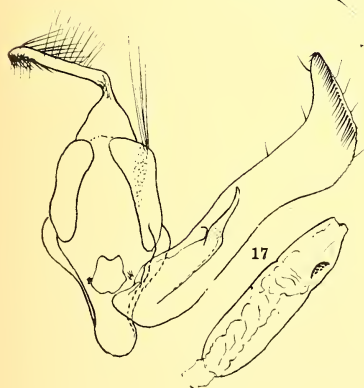
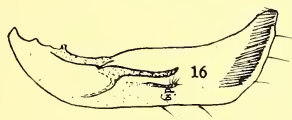
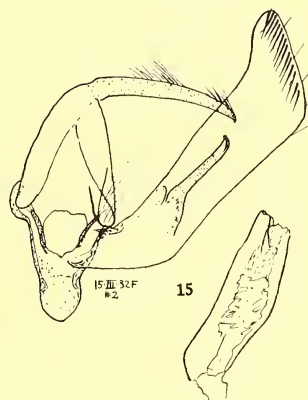
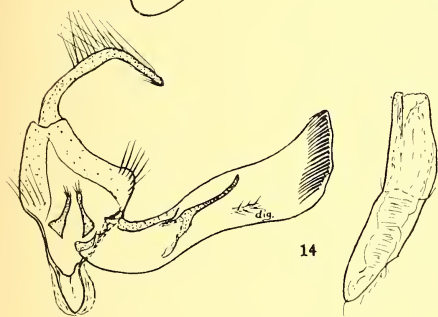
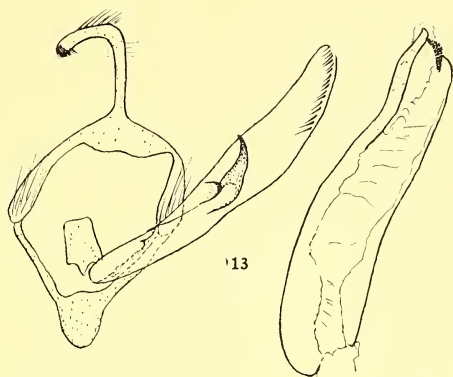
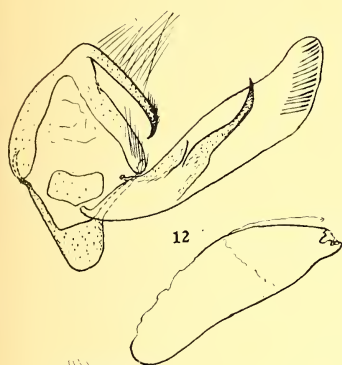


PLATE IV

- Fig. 19. *Agrotis bilitura*, Lima, Perú
20. *A. orestica*, Matucana, Perú, *type*
21. *Tripsauxoa carneata*, Lassance, Minas, Brazil, *type*
22. *Peridroma margaritosa*, New York (valve only)
23. *P. (Hemieuxoa) rudens*, Jemez Mts., New Mexico (valve only)
24. *P. (H.) conchidia*, Coquimbo, Chile (British Museum)
25. *P. (H.) polymorpha*, Lima, Perú, *type*

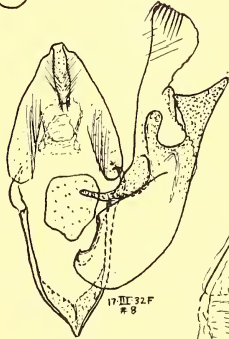
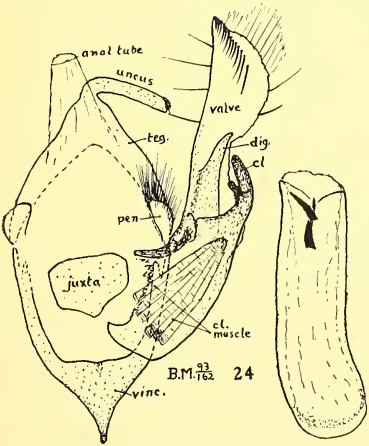
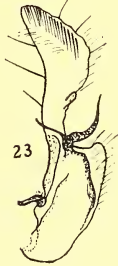
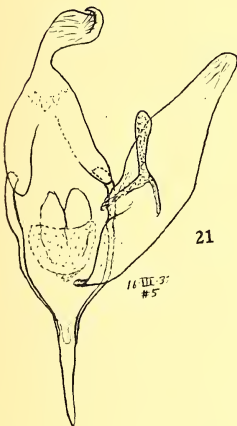
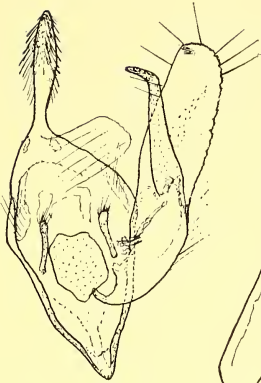
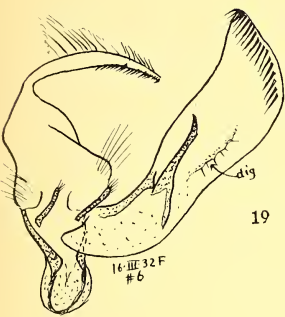


PLATE V

Fig. 26. *Peridroma (Hemieuxoa) microstigma*, Potrerillos, Argentina

27. *P. (H?) messia*, Chile

28. *P. (H?) ferruginescens*, Agualani, Perú (Rosenberg)

29. *Pareuxoa lineifera*, Chubut, Patagonia, *genotype* (Rosenberg)

30-37. Claspers of species of *Peridroma* in the broad sense, showing the gradual modification and homologies of the lobes. In each figure the costal lobe (ampulla) is black, the dorsal lobe (clasper proper) is stippled, and the tip of the costal thickening is marked with cross-lines

30. *Peridroma margaritosa*

34. *P. microstigma*

31. *P. polymorpha*

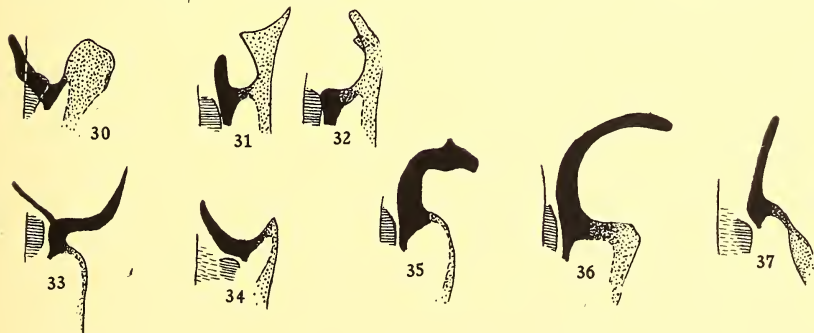
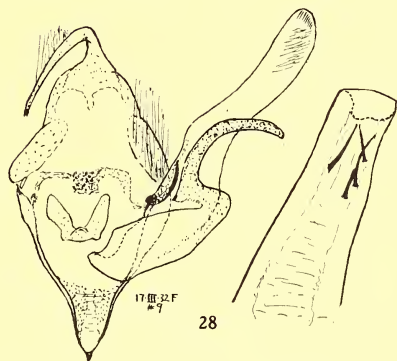
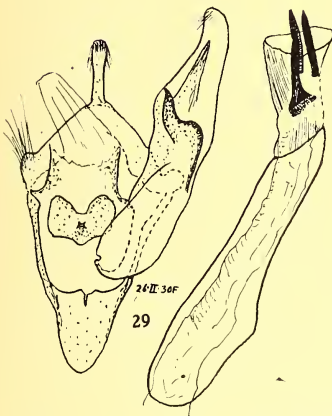
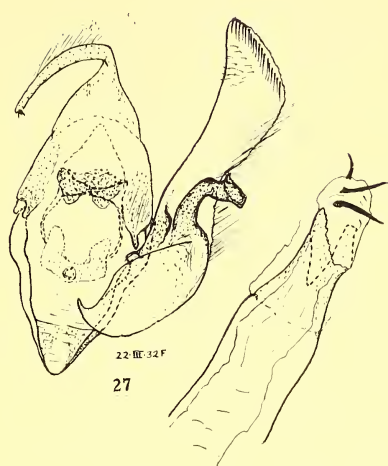
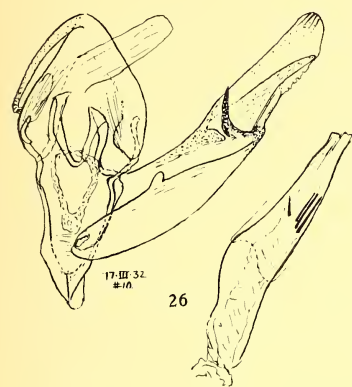
35. *P. messia*

32. *P. conchidia*

36. *P. ferruginescens*

33. *P. rudens*

37. *P. infecta*



FORBES: A Grouping of the Agrotine Genera. Diagram
Showing Relationships of Subgenera
(Genera of McDunnough)

Explanation of Symbols

1 -3 differences

34-6 "

64-9 "

91-12 "

124-14 "

14 $\frac{1}{2}$ -15 $\frac{1}{2}$ "



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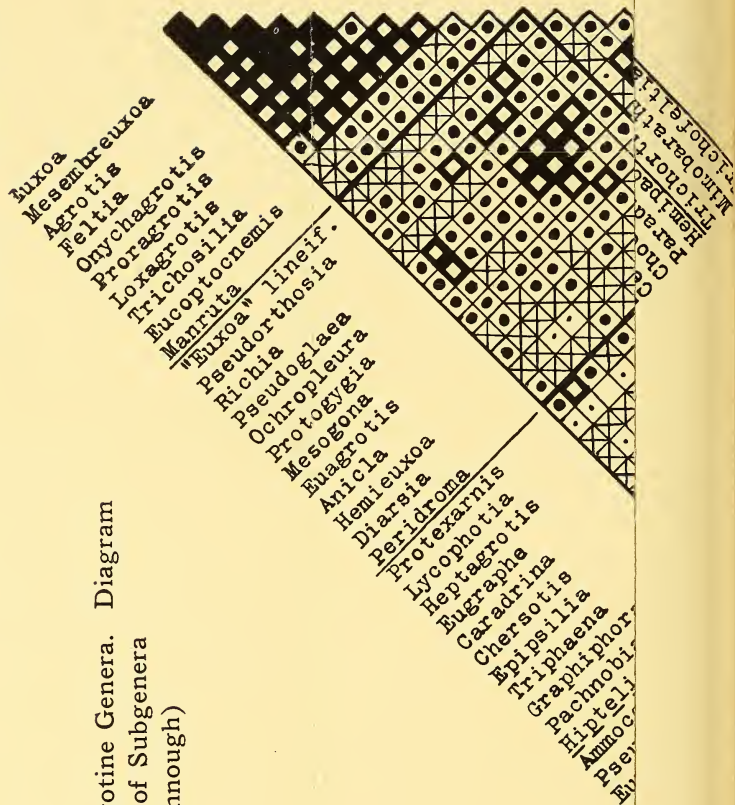
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For explanation of this diagram
see text, page 6.

FORBES: A Grouping of the Agrotine Genera. Diagram
Showing Relationships of Subgenera
(Genera of McDunnough)

Explanation of Symbols

1 - 3 differences	
3½-6	
6½-9	
9½-12	
12½-14	



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HEAD CHARACTERS OF THE ODONATA

With Special Reference to the Development of the Compound Eye

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I. INTRODUCTION

In the order Odonata the head characters are of great taxonomic value. Aside from mouthparts, they have been little studied. The aim of the present paper is to present facts concerning head structure that have been investigated and observed and to indicate their bearing on relationship within the order.

II. THE PRINCIPAL TYPES OF THE ODONATE HEAD

The form of the head in the Order Odonata exhibits great variations. The most obvious fact is the extraordinary development of the organs of sight. This development is accomplished either by enlarging the two compound eyes so as to increase the field and the number of the optical elements, as in the Anisoptera; or by pushing the compound eyes far apart, placing them on the lateral stalk-like ocular lobe so as to facilitate a wider range of vision, as is exhibited in the Zygoptera. The maximum development of both of these plans has been reached by the higher forms of the two suborders, and at the same time, the stages which lead up to these results are still preserved in the different lower forms. Thus we have the following principal types of head forms.

ANISOPTERA

The Gomphinae and the Petalurinae.—These lie nearest to the primitive type. The eyes are not excessively large and are wide apart; width of epieranium separating the eyes is less than the diameter of the eye. Occiput broad, forming an occipital shelf; vertex variable; ocelli arranged into an approximately straight transverse line; antennae four-segmented. Example: *Gomphus abdominalis*, Pls. VII; VIII, Fig. 1, and Pl. XV, Fig. 5.

The Cordulegasterinae.—The eyes become more or less approximated on the dorsal side but just fail to touch each other (some members of this sub-family have eyes just meeting at a point); occiput forming a shelf, subquadrate in shape; vertex flat but much reduced in width on account of the encroaching of the eyes; post and ante-clypeus well differentiated; ocelli are arranged in a nearly straight line; antennae seven-segmented. Example: *Anotogaster kuchenbeiseri*, Pls. VII; VIII, Fig. 2.

The Libellulinae.—The eyes become excessively large, encroaching upon the facial region, and thus affect the size and proportions of the facial sclerites; they meet on the mid-dorsal line for a considerable distance except in *Diastatops*. The front portion of the occiput is compressed into a thin sheet between the eyes, the posterior portion becomes a small occipital triangle; the vertex becomes a raised, constricted plateau with two lateral ocelli sticking out on its sides; its bulging front wall arches over the median ocellus; frons bulging, prominent; antennae six-segmented. Example: *Pantala flavescens*, Pls. VII; VIII, Fig. 3.

The Aeschninae.—The enlargement of the eyes reaches its maximum development. The eyes become enormous, and confluent with

each other along the mid-dorsal line for a great distance; vertex reduced to a very small raised hump, occipital triangle very small; lateral ocelli are not in straight line with the median ocellus; antennae seven-segmented. Example: *Anax parthenope*, Pls. VII; VIII, Fig. 5, and Pl. XV, Fig. 4.

The Epiophlebiidae.—This is probably a side branch of this development. The eyes are enlarged to a great size, approaching each other but failing to touch; occiput becomes reduced to a small sub-circular shelf; vertex is excessively developed, forming a prominent shelf-like structure, projecting far out from the forehead region; the arrangement of the ocelli is most remarkably modified by the abnormal development of the vertex, the lateral ocelli migrate backward and are located at the caudal margin of the vertex being not visible from the front; antennae 5-segmented. Example: *Epiophlebia superstes*, Pls. VII; VIII, Fig. 6.

ZYGOPTERA

The Agrioninae.—The head characters show the most generalized condition in this Suborder. The eyes are separated by a width of epicranium greater than the diameter of a single eye; the post ocular lobe is not well developed, its diameter never exceeds that of the eye; post ocular suture poorly developed; epicranial suture absent; antennae located nearer to the epistomal suture, clavola not segmented, its length always similar to that of the scape and pedicel. Example: *Agrion atratum*, Pls. VII; VIII, Fig. 7.

The Lestinae.—This shows a step of advancement in development, the post ocular lobe is better developed, the dorsal half of the eye is pushed outward, and the inner eye margins are not parallel with each other; clavola of antennae segmented. Epicranial suture present. Example: *Lestes forcipatus*, Pls. VII; VIII, Fig. 8.

The Coenagrioninae.—The higher forms of this sub-family show maximum of head widening. The development of the post ocular lobe is accompanied by a development of the post-genal region; the epicranium becomes transversely elongated forming a kind of cross-stalk carrying the two eyes at its ends; epicranial suture present; antennae located further from the epistomal suture, clavola not segmented, its length greater than that of the scape and pedicel together. Example: *Platynemis annulata*, Pl. VII, Fig. 9.

III. THE ENDOSKELETON

The head of the dragonflies is a specialized structure. The compound eyes have grown to enormous size occupying the greater part of the surface. In order to accommodate these huge visual organs the exoskeleton (facial sclerites) has undergone profound modifications. The endoskeleton (tentorium) though modified and much elaborated, agrees in its construction with the typical arrangement which is characteristic of all the Pterygote insects.

The tentorium consists fundamentally of three pairs of tentorial arms (anterior, dorsal and posterior arms) which originate as hollow invaginations of the head wall. These invaginations grow deep into the head cavity until they meet each other just in front of the occipital foramen and fuse across the median line to form a central tentorial body; this is shaped like a transverse bar, appearing as the floor of the foramen.

The anterior and dorsal pairs of the arms are typical. Modifications of the tentorium occurs however in the occipital region. In most of the generalized insects the tentorial pits are plainly to be seen and serve for the identification of the origin of the tentorial invaginations. In the dragonflies the posterior arms are so short and broad and the tentorial pits are so completely fused and atrophied that their presence is almost unrecognizable (Pl. X, Fig. 6). This is true of the adult. But in the nymph stage they are not yet modified and are easily identified.

This modification in the adult stage is evidently brought about by the abnormal development of the nymphal labium. In order to show the nature of this modification and its relationship with the development of the labium, a description of the endoskeleton of the nymphal head is necessary.

A. THE NYMPHAL TENTORIUM

The tentorium of the nymphal head is generalized. The posterior arms lying on the lower ends of the occipital formamen, though short and broad, are recognizable. The tentorial pits (Pl. IX, Fig. 4, pt) are distinct and wide, leaving no doubt as to the identity of these invaginations.

The anterior arms (Pl. IX, Figs. 2, 4, AT) are long and strong, and slightly twisted toward their roots which, when visible, appear as a pair of external pits lying between the gena and the trochantin just above the anterior articulation of the mandible (Pl. IX, Figs. 2, 4 at). On their ventral side there is a pair of mandibular processes (Pl. IX, Fig. 2, mdp); these are delicate tendinous struc-

tures, their distal ends expanded into round flaps buried in the muscles in the body of the mandible. Their function is probably merely that of anchoring the big jaws in place; the movement of the jaw is performed by other bundles of abductor and adductor muscles (Pl. IX, Figs. 2, 4, Ad. Md., Ab. Md.).

The dorsal tentorial arms appear as a pair of dorsal off-shoots of the anterior arms (Pl. IX, Fig. 4, DT). This is probably because these two pairs of tentorial invaginations fuse before they make contact with the posterior elements. The outer ends of the dorsal arms do not appear as true invaginations but are tendinous flaps attaching to the hypodermis of the facial wall near the base of the antennae. The points of attachment are indicated externally by slight elevations, one behind each antenna (Pl. IX, Fig. 1, DT).

The body of the tentorium is inconspicuous, extending transversely and appearing as the floor of the occipital foramen (Pl. IX, Figs. 2, 4, Tnt). In many cases there are on the ventral side of this central body two triangular projections (Pl. IX, Figs. 2, 3, VV), to whose surfaces two bundles of trunk muscles are attached. These projections are, however, not constant structures, since they are absent in the Libellulinae. In the Libellulinae the body of the tentorium is somewhat arched, and the maxillary abductor muscles are directly attached to its front border.

The Hypo-labial frame.—The endoskeleton of the nymphal head is complicated by the extraordinary development of the labium. The latter is highly specialized, serving the nymph as an unique raptorial organ. The mentum and the submentum are greatly enlarged and lengthened. The junction between them becomes a hinge, so that the labium, when at rest, can be folded together and directed backward, lying along the ventral surface of the body. The palpi are modified into movable lateral lobes, armed with elaborate hooks. (Pl. XIV and Pl. XVI). Movement of all the parts is controlled by muscles, tendons and ligaments, and during the action the whole organ can be thrown straight out with lightning-like rapidity. A powerful organ like this will naturally require some special device for its support. This requirement is fulfilled by an interesting modification of the hypopharynx.

The base of the submentum occupies an enormous space as shown in Plate IX, Figs. 3 and 5. This space, the labial cavity, is chiefly braced with an anchor-like structure. The long shank of this structure extends posteriorly from the hypopharynx and traverses the entire length of the labial cavity, dividing the latter into two lateral halves. The crown (Cwn) of this structure sits

in a small pocket on the base of the submentum (Sml. pkt), while the two curved arms (Lat. a.) fit against the caudal rim of the cavity each terminating in a round fluke supporting the two latero-caudal corners. The antero-lateral rim of this cavity is framed by a pair of chitinous bars (HS). These, together with the anchor-like structure, form a complete framework, the sub-labial frame, supporting the whole circumference of the labial cavity and rendering it a strong base for the accommodation of the huge labium.

This anchor-like structure is obviously a modification of a hypopharyngeal apodeme. The mouth of the invagination (Pl. IX, Fig. 5, Mth) remains wide open like a pocket on the ventral side of the organ, the shank being merely a hollow tube. The chitinous bars on the antero-lateral corners of the labial cavity are the suspensorial plates of the hypopharynx found in common among the Pterygotes, but in this case very much enlarged. This sub-labial frame is found throughout this order of insects. In the Aeschnidae the labium is very long, the shank bearing at its middle portion a ventral projection, prominent and slightly curved downward and backward (Pl. IX, Figs. 5, 6, Vk). This is characteristic of this group and is not found in other Odonates.

The pair of triangular ventral projections on the body of the tentorium which has been mentioned above, when present, may also serve as a guide for the long shank of the sub-labial frame, because the shank, like the ventral nerve cord lies between them. The real relationship of these structures needs further investigation.

B. THE ADULT TENTORIUM

During the nymphal stage the submentum also covers the entire post-occipital region including the posterior tentorial arms and the lower half of the occipital foramen and consequently those parts that are covered remain membranous. During metamorphosis the big labium is cast off, and the original labial cavity is only in its lower half covered by the thin, plate-like adult labium (Pl. X, Fig. 6). The exposure of the upper half of this cavity brings about an extensive chitinization of the lower occipital region. The short and broad posterior tentorial arms are somewhat more expanded and become so heavily chitinized that their external pits become completely closed. In some species the mouths of the original pits can be detected as a pair of dark lines. This accounts, as has been already stated, for the obscurity of the typical tentorial arrangement of this caudal region.

In the Libellulinae there is a pair of occipital processes extending from the upper corner of the posterior arms, quite up to the upper margin of the sclerite (Pl. X, Fig. 3, ocp). Specimens treated with potash show that these processes are merely foldings of the occipital wall. This is probably a secondary development for strengthening the occiput, since it is present only in the Libellulinae, which are highly specialized forms in which the occiput attains the maximum size.

The true front border of the Odonate cranium is an internal epistomal ridge, lying between the anterior articulations of the mandible; with both ends in connection with the genae (Pl. X, Fig. 3, 5, er). This internal ridge is indicated externally by an epistomal suture, more commonly known as the fronto-clypeal suture since it is the dividing line of the frons and the clypeus. In dragonflies this epistomal suture is very prominent and deep, because the frons and clypeus are highly elevated (Pl. X, Fig. 4, er). The inturned edges of these sclerites along this suture fuse into a broad chitinous fronto-clypeal shelf (Pl. X, Figs. 4, 7, F. C. shf). The inner border of this shelf joins the internal epistomal ridge forming a strong bridge which braces the articulations of the jaws (Pl. X, Figs. 2, 3, 5, er). On both sides of this bridge, just beyond the mandibular articulations, are the external pits of the anterior tentorial arms. These are narrow slits lying between the genae and the trochantins. The latter are reflexible areas between the genae and the bases of the mandibles. The anterior tentorial arms, shaped like twisted flat tubes, extend from these pits inward and upward into the head cavity until they reach the caudal part of the cavity, where they join the body of tentorium (Pl. X, Figs. 4, 7, 8, At, Tnt). On the ventral surface of the anterior tentorial arms there are two pairs of processes. The anterior two of these are the mandibular processes (Pl. X, Figs. 4, 8, Mdp), they are delicate and tendinous, very similar to those of the nymphal tentorium; their round tips are inserted in the heavy muscles of the mandibles. The posterior pair are the maxillary processes (Pl. X, Figs. 4, 7, 8, Mxp), they are heavy projections arising from the inner end of the arm and with the maxillary abductor muscles attached to their anterior surfaces. These maxillary processes are not found in the nymphal head, but functionally they are homologous with the ventral triangular projections of the central body of the latter. The shifting of the maxillary muscles to this anterior position is probably due to the increase of the depth of the head through the metamorphosis.

The dorsal pair of the tentorial arms is always the simplest. They extend from the dorsal side of the inner ends of the anterior tentorial arms, straight to the bases of the antennae (Pl. X, Figs. 4, 7, 8, Dt). The most marked difference between the dorsal tentorial arms of the adult and those of the nymph is that in the latter the outer ends are merely tendinous flaps attached to the hypodermis of the facial wall, while, in the adult these ends are represented by a pair of tentorial pits (Pl. X, Fig. 1, Dt). These pits are not visible in natural condition but can be traced when treated with potash. In the Sub-order Zygoptera, especially the Agrionidae, these dorsal tentorial pits are very distinct.

Another pronounced change in head of the dragonflies during metamorphosis is the extraordinary development of the compound eyes. The disturbance caused by the extension of these enormous visual organs into the facial area and the subsequent readjustment and modifications of the facial sclerites, is very remarkable, and will be discussed in another section of this paper. It is interesting, however, to see how the endoskeleton is involved in this abnormal development. Figure 1 of plate X illustrates the construction of the orbit of the compound eyes. This construction brings into cooperation three sclerites: the greater part of the ring is formed by the occiput which extends from beside the constricted vertex, arches over and covers the entire caudal and lateral sides; the front side of the ring is formed by the reflexed lateral edge of the frons (Fr.); the ventral side is formed by the gena. In the more primitive forms such as the Gomphidae, the genae, while serving as a part of the orbit, at the same time are exposed as part of the face (Pl. VII, Fig. 1). In the highly specialized forms the genae are completely concealed by the big eyes (Pl. VII, Figs. 3, 5). They serve not only as a part of the orbit but also for the attachment of the frons, and so have eventually become a part of the endoskeleton. Since the anterior tentorial arms arise as invaginations on the genae, these structures are in direct continuation one with another. And since the epistomal ridge is also in direct connection with the genae, therefore the tentorium, epistomal ridge and the genae form together an endoskeletal frame (Pl. X, Figs. 2, 4, 5). The trochantin which is counted by some authors as an individual sclerite of the head is also in direct continuation with the anterior arm. It is probably only an extension of the external end of the arm.

IV. THE EXOSKELETON

A. THE FACIAL REGION IN THE ANISOPTERA

Representatives of eighteen genera of Anisoptera were measured as to the length of each of the six facial sclerites, occiput, vertex, frons, postclypeus, anteclypeus, and labium, and the results are in part presented in the following table: The measurements were made with a micrometer eyepiece and reduced to comparable units.

The systematic range of the species measured is as follows: Numbers 1 to 8 of the following table are Aeschnidae, the first four being Aeschninae (*Gynacantha subinterrupta*, *Anax parthenope*, *Aeschnophlebia longistigma*, *Nasiaeschna pentacantha*), the fifth, Cordulegasterinae (*Anotogaster kuchenbeiseri*), and the sixth, seventh and eighth, Gomphinae (*Progomphus obscurus*, *Octogomphus specularis*, *Hagenius brevistylus*).

The last nine are Libellulidae, the first three being Cordulinae (*Epiptera marginata*, *Epicordulia princeps*, *Tetragonuria cynosura*), the next a Macrominae (*Epophthalmia elegans*), with the last five Libellulinae (*Pantala flavescens*, *Tramea chinensis*, *Crocothemis servilia*, *Acisoma panorpoides*, *Pseudothemis zonata*).

The last one is the rare and interesting sole representative of its family Epiophlebiidae: *Epiophlebia superstes*.

TOPOGRAPHICAL MEASUREMENTS OF THE FACIAL REGIONS OF
ODONATA-ANISOPTERA

No.	Occiput		Eyes		Frons		Clypeus		Labr.
	W.	L.	C.	D.	Post	Ante	Post	Ante	
1	2.6	3.0	10.0	0.0	7.0	6.0	7.0	2.6	5.0
2	2.5	2.0	10.0	0.0	10.0	6.0	10.0	3.0	5.0
3	6.5	4.5	8.0	0.0	8.0	5.0	10.0	3.7	6.5
4	5.0	4.0	6.0	0.0	10.0	4.0	8.0	3.0	5.0
5	10.0	6.0	0.0	7.0	8.0	4.6	4.0	5.0	8.0
6	10.0	4.0	0.0	5.0	4.5	3.0	3.0	4.5	6.7
7	10.0	2.7	0.0	7.3	6.5	3.3	2.3	2.3	4.5
8	10.0	4.5	0.0	5.0	6.0	5.0	3.3	3.5	4.5
9	10.0	6.5	2.5	0.0	9.0	5.0	5.0	2.5	5.0
10	10.0	5.5	5.6	0.0	10.0	5.0	6.7	7.5	5.7
11	10.0	8.3	5.0	0.0	8.3	10.0	1.5	5.6	6.6
12	6.0	6.0	2.0	0.0	10.0	6.0	9.0	0.6	8.0
13	10.0	8.5	6.5	0.0	6.6	6.0	6.6	3.8	3.8
14	9.0	9.0	3.6	0.0	10.0	5.0	10.0	1.3	5.0
15	8.3	8.3	3.4	0.0	8.5	9.0	10.0	1.6	6.6
16	8.0	6.3	0.8	0.0	8.0	10.0	4.0	2.0	6.0
17	8.3	10.0	1.6	0.0	0.0	0.0	4.0	2.5	5.6
18	6.7	3.5	0.0	6.7	8.5	10.0	5.0	3.5	6.7

In the preceding table the longest measurement is represented by the numeral 10 and the others by proportionate measurements. Column headings in this table indicate for the occiput, W—width, L—length; for the eyes, C—length of the suture when conjoined, and D—distance between eyes when separate; for the frons and clypeus, Post—the superior, and Ante—the anterior measurement on midline, and for the labrum, length.

In all these Anisoptera the head is wider than long, the excess in width ranging from one-eighth greater in *Aeschnophlebia* to one-half greater in *Anotogaster*. The vertex was so varied in form as hardly to admit of comparable measurements. It is smallest in the Aeschninae and largest (10) in *Epiophlebia*.

B. THE FACIAL REGION IN THE ZYGOPTERA

In the head of the Anisoptera sutures separating occiput from vertex and vertex from frons are present, the sclerites although greatly modified in size and shape are yet recognizable. In the Zygoptera the above mentioned sutures are absent. Because of this it is difficult to determine homologies of the sclerites. In the Coenagrionidae an additional suture is secondarily developed as a result of the excessive enlargement of the postocular lobe. This suture, described more fully in the latter chapter, is designated by the writer as the postocular suture (Pl. VII, Fig. 8). Garman¹ called this suture the epicranial suture. If his supposition is correct then the frontal region would include the antennae and all three ocelli which is contrary to the more commonly accepted belief that the antennae are never included in the frons. Snodgrass in his recent work on the head of insects² says “. . . The muscles of the labrum, some of the dilator muscles of the pharynx, and the retractors of the mouth angles, when present, have their origin on the frons. By these characters, especially the position of the median ocellus and the origin of the labral muscles, the true frontal region is to be identified when the frontal suture is imperfect or obsolete.”

Fortunately the majority of the Coenagrioninae have both this postocular suture and the epicranial suture well preserved, leaving no doubt as to the identity of the frons. In this study the posterior

¹ Garman, P. The Zygoptera or Damselflies of Illinois. Bul. Ill. Sta. Lab. of Nat. Hist. 1917. 12. p. 423-424. pl. LX.

² Snodgrass, R. E. Morphology and evolution of the insect head and its appendages, Smithsonian Miscellaneous Collections. Vol. 81. p. 121-122.

edge of the median ocellus has been used as the caudal boundary of the frons when the epicranial suture is not present, and the measurements were taken from this point.

Measurements were made also of the head topography of thirty-nine genera of Zygoptera of which the systematic range was as follows: In the thirteen Agrionidae used were representatives of seven Agrioninae and six Epallaginae. In the twenty-six genera of Coenagrionidae, two were Megapodagrioninae, five were Lestinae, and nineteen were Coenagrioninae. The measurements taken were width and length of head and of occiput, diameter of the eye, length of vertex, of frons, of postclypeus, of anteclypeus, and of labrum. There is space here for only the means of the measurements taken and these are again expressed in terms of 10, this numeral always representing the width of the head which is the longest of these measurements. The others are in proportion.

COMPARISON OF THE MEANS OF MEASUREMENTS OF THE HEAD OF THE FIVE SUBFAMILIES OF ZYGOPTERA

	Head : W. : L.		Occiput : W. : L.		D. of E.	L. of V.	L. of F.	L. of Pe.	L. of Ac.	L. of Lr.
Agrioninae	10	5.1	2.5	.20	4.6	1.3	1.7	0.8	0.8	1.0
Epallaginae	10	4.9	2.2	.20	4.4	1.1	1.9	0.9	0.8	1.0
Megapod'nae	10	5.1	2.4	.40	4.4	1.0	1.9	0.9	0.7	1.1
Lestinae	10	4.9	2.3	.20	4.8	1.0	1.8	0.8	0.9	1.1
Coenagr'nae	10	4.4	2.1	.19	4.9	0.9	1.9	0.8	0.7	1.1

In striking contrast with the Anisoptera, where the enormous enlargement of the compound eyes greatly affects the size and proportions of the facial sclerites, the Zygoptera are remarkably uniform.

A few of the head characters of the Zygoptera are of considerable taxonomic value. These characters are, briefly, as follows:

a. **The epicranial suture**, when present, begins near the caudal margin of the dorsum, extends forward between the lateral ocelli and forks just behind the median ocellus. The branches extend only for a short distance, rarely beyond the base of the antennae as is best shown in the *Lestes* (Pl. VII, Fig. 8). This suture is present in every Coenagrionine but is absent in the Agrioninae—*Hetaerina* being the exception of the latter group.

b. **The postocellar suture**, in its median portion, when well developed is closely parallel to the hind margin of the dorsum. Its ends extend latero-anteriorly behind the ocelli to the inner margin of the compound eyes. In the Coenagrionidae this suture is distinct and serves as a dividing line, separating the postocular lobe from the facial regions (Pl. VII, Fig. 8). In the Agrionidae however this suture is not well developed, being represented only by a pair of short transverse grooves running mesally from the inner margins of the compound eyes (Pl. VII, Fig. 7).

c. **The antennae** are always located below the level of the frontal suture (Pl. VII, Fig. 7) in the Agrionidae, while in the Coenagrioninae the location of the antennae is always above or on the same level with the frontal furrow (Pl. VII, Figs. 8, 9).

d. **The postocular lobe** is always more developed in the Coenagrionidae than in the Agrionidae. In the former its diameter often exceeds that of the compound eye.

e. The number and relative length of the segments of the antennae. This will be discussed in the next section.

V. THE ODONATE ANTENNA

The antennae of this order are all short and inconspicuous. They are all setaceous, but vary considerably in shape and in number of segments. The basal two segments (scape and pedicel) are much thicker; the clavola or flagellum is slender and bristle-like, consisting of from one to five segments.

The antennae of the Gomphines are of four segments (Pl. XI, Figs. 1, 11). The last segment is the longest and is much longer than the others. The scape and pedicel are usually similar in length.

With the exception of a few primitive forms, the antennae of the Aeschnines are of seven segments. The third segment is the longest, the fourth is the shortest, especially in *Anaciaeschna* (Pl. XI, Fig. 3). The antennae of *Gomphaeschna* have only five segments and the third is the longest (Pl. XI, Fig. 8). The antennae of the *Caliaeschna* has only six segments (Pl. XI, Fig. 10), the second segment being the longest.

The Cordulegasterinae, also, have seven-segmented antennae. The pedicel is the longest segment (Pl. XI, Fig. 2). The third segment comes next in length, and the scape is short, being only half as long as the pedicel. The distal four segments are similar in length.

The Cordulines and Macromiines are very similar, the antennae being composed of six segments; (Pl. XI, Fig. 4). The third is longest. The other segments, including the scape and pedicel, are uniform in length.

All the Libellulines have six-segmented antennae, and the majority have the last segment longest. The third segment is longest in *Potamarcha*, *Pantala*, *Tramea*, and *Trithemis*. In *Sympetrum* the third and sixth are nearly equal in length.

In the isolated and very peculiar *Epiophlebia* the five-segmented antennae have the second joint nearly twice as long as the third, broadly dilated and hairy on the lateral margins.

In the Sub-order Zygoptera, with the Lestines as the only exception, the clavola is not segmented, and the number of the segments in the antennae, therefore, is three.

In the Agrioninae the clavola is the longest segment. The scape and pedicel are similar in length and are always longer than half the length of the clavola. *Hetaerina* is an exception in that the scape is slightly longest (Pl. XI, Fig. 17).

In Coenagrioninae the clavola is longest but the scape is noticeably longer than the pedicel (Pl. XI, Fig. 14) and it is always shorter than half the length of the clavola.

In the Epallaginae the clavola is also the longest; the two basal segments are not constant in length, their characters fluctuating between those of the Agrioninae and Coenagrioninae.

In the Lestinae the clavola is two-segmented (Pl. XI, Fig. 3). In several cases three segments are observable, but in that case the distal two segments are never well differentiated. The segmented condition of the clavola is best shown in *Sinolestes* (Pl. XI, Fig. 21).

The form of the adult antennae is not correlated with that of the nymphal stages, especially when the length of the segments is concerned. In the nymph of Agrionines the scape is hypertrophied; its length exceeds that of all the remaining segments put together; while in the adult stage it is the unsegmented clavola that is longest (Pl. XI, Figs. H and 18). Another good example is *Hagenius*. In the nymph of this species the third segment is flattened and very broad (Pl. XI, Fig. B), while in the adult this segment is the shortest and the fourth segment very long.

The segments of the clavola of the insect are never provided with muscles. This suggests that the sub-segmentation of the clavola is a secondary character. The fully developed Odonate nymphs with the exception of the burrowing forms—Gomphines,

PROPORTIONATE LENGTH OF ANTENNAL SEGMENTS IN ADULT ANISOPTERA

	Segments						
	1	2	3	4	5	6	7
<i>Progomphus obscurus</i>	2	2	1.5	10			
<i>Octogomphus specularis</i>	3	3	2	10			
<i>Ictinus pertinax</i>	3.5	3.5	3	10			
<i>Gomphidia confluens</i>	2	3.5	2	10			
<i>Anisogomphus flavescens</i>	2	2	1	10			
<i>Gomphus abdominalis</i>	2	2.5	1.5	10			
<i>Lanthus albistylus</i>	2.5	2.5	2	10			
<i>Zonophora batesi</i>	1.5	1.5	1	10			
<i>Gomphaeschna furcillata</i>	7	8	10	6	5		
<i>Caliaeschna</i> sp.?	4	10	6	3	3		
<i>Basiaeschna janata</i>	5.5	8.9	10	6	6.7	5.5	4.5
<i>Aeschna umbrosa</i>	5	5	10	5	6	5	5
<i>Anax junius</i>	5	6	10	4	6	6	5
<i>Planaeschna</i>	4	7	10	4	5.5	5.5	4
<i>Gynacantha subinterrupta</i>	5	6.5	10	4	5	6	5
<i>Anaciaeschna jaspidea</i>	4	6	10	1.5	3	3.5	8
<i>Chlorogomphus papilio</i>	4	10	4	2.5	2.5	2	2
<i>Anotogastes kuchenbeiseri</i>	5	10	9	4	5	5	4
<i>Cordulegastes diastatops</i>	5	10	7	3	3	3	4
<i>Epiophlebia superstes</i>	4	10	6	3	3		
<i>Epophthalmia elegans</i>	6	6	10	5	5	6	
<i>Epithecina marginata</i>	6	7	10	7	8	8	
<i>Tetragonuria cynosura</i>	6.7	7.5	10	7.5	8	8.5	
<i>Didymops transversa</i>	7	7	10	6.5	8	9	
<i>Nannophya pygmaea</i>	3	6	5	2	4	10	
<i>Diplacodes trivialis</i>	4	7	8	6	7	10	
<i>Neurothemis tullia</i>	4	6	7.5	5	7.5	10	
<i>Deielia phaon</i>	5	7	7	4	7	10	
<i>Brachythemis contaminata</i>	4	6	6	3.5	6	10	
<i>Crocothemis servilia</i>	3	7	8	4	6	10	
<i>Celithemis amanda</i>	5	7.5	10	7.5	7.5	9	
<i>Rhyothemis fuliginosa</i>	6	7	8	5	6	10	
<i>Palpopleura sexmaculata</i>	3	6	6	3.5	4	10	
<i>Libellula angelina</i>	4	7	8	5	6	10	
<i>Othetrum albistylum</i>	6	7	9	5	6	10	
<i>Lyriothemis pachygastra</i>	5	7	8	5	5	10	
<i>Pseudothemis zonata</i>	3	5	8	5	5	10	
<i>Brachydiplax chalebea</i>	4	6	7	6	7	10	
<i>Sympetrum baccha</i>	4	7	10	6	7	9.8	
<i>Plathemis lydia</i>	4	6	10	7	7	10	
<i>Acisoma panorpoides</i>	4	6	7	4	6	10	
<i>Tramea chinensis</i>	3	3.5	10	6	8	10	
<i>Pantala flavescens</i>	3	7	10	5	6	7	
<i>Hydrobasileus croceus</i>	4	5	9	6.5	9	10	
<i>Tholymis citrina</i>	5	5	8.5	5	7	10	

which have four (Pl. XI, Figs. B and C), and Petalurines, which have six segments (Pl. XI, Fig. 1)—all have seven-segmented antennae (Pl. XI, Figs. D, E, F, G, H). The reduction of the number and size of segments of the adult antennae is therefore a matter of degeneration. The degeneration of this organ is no doubt correlated with the extraordinary increase of visual power, which is one of the most prominent characteristics of the order.

The data on which the preceding generalizations are based is in the preceding table. The longest segment is set down as 10; the others in proportion.

VI. DEVELOPMENT OF THE COMPOUND EYES

A. DEVELOPMENT DURING THE NYMPHAL STAGE

The external features of the nymphal head.—A few terms applied to the larval head need to be defined, since they will be mentioned frequently in the following discussion. A full description of the general structure of the larval head is not necessary.

The dorsal aspect of *Aeschna* larvae of young, mature and intermediate stages are shown in Plates XII and XIII, Fig. 1. During the early instars the sutures of the upper facial region are not distinct, the epicranial sclerites can only be referred to according to their respective regions. In an older larva the positions of the ocelli which usually indicate the boundary of the vertex became clearly marked on the cuticle. Thereafter the sclerites of the epicranial region can be more definitely distinguished. The figures show that the eyes are antero-laterally placed. The occiput is conspicuous, and expands laterally into two prominent postocular lobes. The coronal or epicranial suture (Epi.S) is very distinct. It extends from the occipital foramen to the anterior border of the occiput where it forks abruptly; each arm turns at a right angle and extends laterally outward until it meets the caudal angle of the eye. In later development the caudal angles of the eyes grow like wedges and invade the occipital region along these sutures. The vertex is marked off posteriorly by the arms of the coronal suture, anteriorly and laterally by the developing ocelli. In *Gynacantha* this sclerite is almost a perfect square. The frons is bounded posteriorly by the median ocellus and anteriorly by the epistomal (fronto-clypeal) suture which is always very distinct. On each side of the frons is the base of an antenna; instead of being a typical ring-like antennal sclerite it appears like an extra segment of the antenna. The antennae are much more prominent than in

imago. The clypeus and labrum are well formed. Lateral and closely adjacent to the base of each antenna is an ovate cuticular elevation, this is the external sign of the attachment of the dorsal tentorial arm (Dt). Immediately lateral to this tentorial elevation, and extending all the way along the inner border of the eye is a long and wide crest-like structure; the cuticle of this whole region is tough and much wrinkled (B.Z.) This structure is of great importance in the development of the compound eye. The thick cuticle serves as a roof covering the underlying tissue which, as later experiments confirm, consists entirely of young buds of future ommatidia. This special feature is designated under the name "Budding-zone."

The most striking character of the Odonate larval head is the labium. It is highly specialized, and unique in the animal kingdom. Its structure and function have been described in the section dealing with the larval tentorium. A lateral view of the head of an Aeschnine larva (Plate XIV, Fig. 3), shows that the labium in the Aeschninae is greatly elongated. The distal half is flat and straight, and when at rest the whole organ is folded and concealed under the head. The head is also dorso-ventrally flattened; it appears as if the two were so modified to accommodate each other.

In Libellulidae the labium is more elaborate. The median lobe is projecting and triangular; the lateral lobes, formed by the original labial palpi, are huge, triangular and very concave. They meet together along their distal borders above the median lobe. The whole organ is spoon-shaped (Plate XIV, Fig. 1, and Plate XVI, Fig. 4), and covers the lower half of the face like a mask. The head is more or less spherical.

In a flat head like that of the Aeschninae, the front surface is greatly reduced and the eyes tend to spread out more or less in a single plane. But, when a head is sub-spherical, as in the Libellulinae, it offers a great space on the front side for the development of the eyes. Another point of difference is that in the Libelluline larval head the cuticle covering the budding-zone does not form a shelf-like structure as in the Aeschnine larva; however, its location and boundaries can be clearly made out.

Experiments on the nymphs of Aeschninae.—The materials used for this experiment were young larvae of *Aeschna umbrosa*. Definite spots on the eye region of the young larval head were chosen and pricked with a fine needle to make slight wounds. The larva was then fed and its activities closely observed. Soon after the ecdysis, a careful examination was made of the growing

head to trace the scars of the wounds, and the locations of these scars were then compared with those retained by the exuvium. Drawings were made to record the results. The same process was repeated on the same individual for a number of successive instars. The new prickings were made, each time, at least several hours after the molting in order to permit the expansion of the head which follows ecdysis.

The experiment was started on a very young larva with a head-width of 3.5 mm. Two punctures were made with a fine insect pin on the right eye region (Pl. XII, Fig. 1, scars Nos. 1, 2). Wound No. 1 was made on the root of the dorsal tentorial arm close to the base of the antenna: No. 2 was made on the middle of the budding-zone at the same level as No. 1. Since the head was so small the two punctures appeared very close to each other.

Having been wounded the larva dashed around in the water, then dived to the depths of the aquarium and attached itself to the under side of a stick with its head invariably pointing towards the bottom. Hiding from the strong light it remained motionless for a considerable length of time, but finally recovered from the excitement and began to feed voraciously.

The larva molted on August 17th, the size of the head was increased. The wounds caused by the prickings were carried by the growing head, partly concealed under the new cuticle and yet distinctly visible. The location of No. 1 remained unchanged because the wound fell upon tissues outside of the growing eye (Pl. XII, Fig. 1). The position of No. 2 moved laterally and came to lie on the outer edge of the budding-zone (Plate XII, Fig. 2).

Another remarkable fact following the molting was the appearance of a band of new tissue along the inner margin of the eye (Pl. XII, Fig. 2, N.T.). It was pale and contrasted plainly with the remaining parts of the eye which were more and less pigmented. The cuticle covering this band of new area was composed of small, compact and not well shaped facets, this structure being visible only with careful adjustment of focus under the binocular.

The scars of the wounds on the exuvium were very distinct; they were not new holes but were healed up, thickened and dark brownish in color. They remained in the same places where they were first made. Since the larva was still very young no additional wounds were made at this time. Towards the end of the instar it was observed that the new tissue became much darker in color, especially along the extreme boundary of the budding-zone where dark pigment granules were heavily distributed among the growing cells.

The larva molted again on August 31 (head-width of exuvium 4.5 mm.). Again a band of new tissue appeared on the inner margin of the eye (Pl. XII, Fig. 3, N.T.). Scar No. 1 sank deeper under the cuticle, still remaining on the same spot. Scar No. 2 now moved to the outside of the budding-zone; being pushed out by the new tissue. The scars became less distinct and were covered by new cuticle which bore almost no trace of damage (Pl. XII, Fig. 3, 2).

Since the larva had grown bigger it was then possible to experiment on both eyes. Two additional punctures were made, therefore, on the left eye (Pl. XII, Fig. 3, 3, 4): No. 3 was made on the extreme outer edge of the budding-zone (a position comparable to No. 2 in Fig. 2). No. 4 was made on the dividing line between the pigmented and unpigmented tissue (a position exactly corresponding to No. 2 on the right eye). This puncture was made as a duplicate of No. 2 because the ommatidia covered by No. 2, although damaged, became more normal after each successive instar; their expansion caused the scar to become diffuse.

The next molting took place in September 14th (head-width of exuvium 4.9 mm.). Again a band of new tissue appeared on the inner margin of the eye, its caudal end showing slight differentiation (Pl. XII, Fig. 4, N.T.). It was noticed that the length of the band of new tissue increases rapidly instar after instar especially on the posterior half, its extension gradually invading the occiput. Scar No. 1 now became deeply buried under thick chitin, its location still remaining unaltered. Scar No. 3 moved from the edge of the budding-zone and became lodged on the new boundary line between the new and older tissues exactly in the same way as had happened to No. 2 in the previous molting. Scar No. 4 moved laterally and appeared within the pigmented region of the eye (Pl. XII, Fig. 4, 1, 3, 4). Another additional puncture was made on the extreme outer margin of the budding-zone (Pl. XII, Fig. 4, 5).

The larva molted again on October 4th, the head was then a little more than 7 mm. in width (head-width of exuvium 6.6 mm.). The scars of the wounds moved laterally as before, only No. 1 remaining unaltered in position. Scar No. 5 was pushed out by another band of new pale tissue; No. 3 moved to the pigmented area; No. 4 moved further laterally and became surrounded by well-shaped facets (Pl. XII, Fig. 5, 1, 3, 4, 5).

The most striking thing appearing in this instar was in the band of new tissue. It became obviously differentiated into two parts. The anterior portion exhibited nothing different from those

of the previous instar, but the posterior portion appeared to be wider and the cuticle covering this portion appeared to be more rough and less transparent (Pl. XII, Fig. 4, 5, Nt., X.). These characters became still more pronounced toward the end of the instar. Unfortunately the larva died during the late period of this instar.

A fully mature larval head of this same species is shown in Pl. XIII, Fig. 1. It illustrates the subsequent development of this differentiated caudal portion of new tissue at the end of the larval life. Further experiments have confirmed that this patch of tissue is destined to form the big facets of the adult eye.

I have reared several larvae of *Anax junius*, a common species of another closely allied genus. An examination of the successive exuviae of any one of these specimens showed very definitely that the tissue destined to form the big facets of the adult eye begins to appear and grows very rapidly during the last three instars (Pl. XV, Figs. 1, 2, 3, X.). This offers a very useful supplement to the part which I failed to carry through in the above experiment with *Aeschna*.

Besides the facts stated above I have also observed the development of a series of longitudinal dark bands across the larval eye. Toward the end of every instar, shortly before another strip of new tissue is added from the budding-zone, black pigment granules form thickly along the intermediate boundary between the eye and the budding-zone (Pl. XI, Fig. 5). After the molting these pigment granules, being pushed out by the new tissue, establish themselves in the eye as a longitudinal dark band marking the boundary of the next older tissue. It was interesting to notice that the wounds made on the extreme outer margin of the budding-zone were found to coincide with the dark bands. This showed quite definitely that the series of dark bands on the eye indicate successive increases of tissue. It would be an excellent means of estimating the age of the larva, by counting the number of instars that the animal has gone through, but for the fact that the bands arising in the first few instars are confusedly combined into one mass, and the exact number of its components is obscured.

Experiments and observations on nymphs of Libellulidae.—I applied the same experimental method to four species of Libelluline larvae (*Plathemis lydia*, *Libellula pulchella*, *Sympetrum vicinum*, and *Tramea lacerata*), and found that the manner of development of the compound eye in these more specialized groups agrees in principle with that of the Aeschninae. That is to say,

that the eye grows by accession of new tissues which arise from the budding-zone and are added to the inner margin from instar to instar. The result obtained from an experiment on *Plathemis lydia* was especially satisfactory because the longitudinal dark bands which mark the successive increases of new tissue are unusually distinct and conspicuous. The scars of the punctures made on the extreme margin of the eye or of the budding-zone were pushed out laterally by the new tissue and were found to coincide precisely with the longitudinal dark bands.

However, there are a few points of difference in details. The subsequent development of the eye tissue in the Libellulidae is more complex, and exhibits some special features which do not occur in the Aeschninae. These points of difference may be briefly stated as follows:

1. As a rule in the Aeschninae the eye tissue when first emerged from the budding-zone is pale and compact, but it eventually becomes pigmented before another stripe of tissue is added. Probably several instars are required to develop functional ommatidia. The larval eye tissues, arising either in the early or in the later instars, all go through the same process of development. In other words, the tissue arising from the successive instars becomes pigmented and develops into ommatidia following an uninterrupted order—all except the patch of tissue on the mesocaudal corner of the eye. This differentiates itself from the remaining parts of the eye, being deprived of pigments and protected under rough and usually pigmented cuticle. This patch of tissue comes from the caudal portion of the tissue arising in the last three instars. *Therefore in the eye of a grown Aeschnine larva there are two sets of distinctly distinguishable tissues* (Pl. XIII, Fig. 1, and Pl. XV, Fig. 3, X and Y).

In the Libelluline larva the tissue arising during the early instars ripens promptly into functional ommatidia. They are densely pigmented and the cuticle covering them develops into regularly six-sided facets. They occupy the dorso-lateral angles of the head and form the definitely projecting eyes of the larva. The late instars give rise to a big patch of tissue the caudal portion of which becomes distinctly differentiated and covered up by roughly wrinkled cuticle just as occurs in the Aeschnine larva. The anterior portion of this late patch of tissue exhibits, however, remarkable differences from those of the preceding instars. It occupies a considerable area extending far forward into the lower facial region. The ommatidia instead of ripening remain rudimentary

and unpigmented and the cuticle of this region never bears regular facets. Not until toward the end of the last instar when the larva is almost mature does this region become rapidly and densely pigmented; after this the last metamorphosis promptly takes place. *Therefore in the eye of a grown Libelluline larva there are altogether three sets of distinctly distinguishable tissues* (Pl. XVI, Fig. 4, X, Y, Z).

2. Usually there are two transverse dark bands which extend between the budding-zone and the older pigmented tissue bridging over the unpigmented area. These dark bands do not appear in the very young larva. They begin to appear when the larva is nearly half grown and become more and more conspicuous as the eye keeps growing. They may be one or two, or they may be totally absent (as in *Pantala*). When two are present the upper one always extends closely along the front margin of the patch of tissue which is covered by rough cuticle and its inner end terminates near the base of the dorsal tentorial arm. The lower one always extends approximately half way between the upper band and the front margin of the eye and has its inner end directed toward the base of the anterior tentorial arm. The significance of these bands is not yet clear.

The longitudinal bands in Libellulinae vary in the different genera. In *Plathemis* and *Libellula* each instar gives rise to a band and the process continues throughout the larval life (Pl. XVIII, Fig. 3). In *Sympetrum* and *Mesothemis* the bands are very distinct, but are present only in the pigmented functional area; the late instars do not give rise to any of these bands. In *Tramea* the pigment granules appear only in the early instars and since they are confused they do not appear as regular rows. In *Pantala* the functional eye area becomes so intensely pigmented that these bands are totally obscured. In *Acisoma* the bands are present in the pigmented area but every one of them is broken at its middle portion so they look as if they were arranged in two transverse rows. In the other genera which I have examined the bands are all present, and their number varies from six to nine (counting the early combined ones as a single band). In most cases they are confined within the pigmented functional area and in many cases they are so diffused that they can be detected only by close adjustment of focus under the binocular microscope.

B. DEVELOPMENT OF THE COMPOUND EYES DURING
THE METAMORPHOSIS

The actual process of metamorphosis begins many days before the time of emergence. The change though internal, is expressed in a number of external characters and also in an alteration of behavior of the nymph.

The imaginal hypodermis of the labium shrinks from the cuticle and gradually retreats to the base of the submentum leaving the elaborate labium an empty shell. For this reason the nymph refuses to feed and remains quietly clinging to its support. In the meantime the color of the body becomes considerably darker and the whole body appears swollen, particularly the thoracic region. Owing to the developing of the large wing muscles, the wing-pads stand up vertically from the abdomen. The compound eyes swell up and extend far beyond the original eye boundary. This expansion of the eyes is distinctly visible through the cuticle, especially in the occipital region where the two eyes approach or actually touch each other pushing the prominent occiput out of its original position (Pl. XVIII, Fig. 2, X, X, X). When these changes are in progress the thoracic spiracles become functional. The nymph protrudes its head and later its thorax from the water. It may remain clinging to its support in this manner for hours or even for several days before emergence.

The transformation which develops the adult eye from nymphal structure is a marvelous phenomenon of nature; a detailed description of which is beyond the scope of this paper. For the benefit of the present discussion the main characters of an adult eye will be here stated. In a typical adult eye of the dragonfly the ommatidia are differentiated into two groups. Those of the upper group have bigger cones, consequently the facets are larger. The pigmentation is usually absent. Those in the lower group have smaller facets and the pigmentation is very dense. In Libellulinae the two portions of the eye show different, or even strongly contrasting, colors. The big and small facets are marked off so sharply that eventually a transitional line appears between them. There is always a gradation between the two groups although the gradation varies greatly in degree among different forms. In some lower forms the change in size is so gradual that a transitional line is almost unrecognizable. The ommatidia on the margin of the eye, especially those on the lateral border where the eye is reflexed backwards, are usually not well formed. The facets of these re-

gions are either deformed or indistinct and the pigmentation is very light or even totally absent. In short, these ommatidia are much less perfect as compared with those which are closer to the facial region.

Material used for this experiment were full grown or younger nymphs collected from different localities at Ithaca, N. Y. The experiments covered the following species:

<i>Aeschna umbrosa</i>	<i>Sympetrum vicinum</i>
<i>Anax junius</i>	<i>Tramea lacerata</i>
<i>Gomphus lividus</i>	<i>Plathemis lydia</i>
<i>Tetragonuria cynosura</i>	<i>Ischnura verticalis</i>
<i>Libellula pulchella</i>	

The experiments were made by the same pricking method. Definite spots on the nymphal eye region were chosen and pricked with fine needle to make slight wounds. After the metamorphosis, when the adult head was fully expanded, a careful examination was made of the adult eye to trace the marks of the wounds and the locations of these marks or scars were then compared with those retained by the exuvium. Since an individual nymph can tolerate only a few wounds without upsetting its normal development, experiments on each species were carried by a number of individuals. The results obtained from the different individuals are here recorded all together on only a few drawings.

I emphasized the fact that the actual expansion of the eye tissue takes place days before the emergence, therefore, in this experiment all of the punctures were made on the nymphal head before the animal became fully mature. Mature nymphs do not serve the purpose.

X, Y and Z Tissues.—In the preceding section I have stated that by the end of nymphal stage different sets of eye tissues are present in the nymphal eye region, and that they grow together like a piece of mosaic. In order to avoid unnecessary repetitions of wording I propose the following abbreviations:

X tissue.—For the tissue which in all cases occupies the posterior corner of the nymphal eye and is covered by wrinkled cuticle, being deprived of pigmentation.

Y tissue.—For the functional nymphal ommatidia which in all cases possess regular facets and are deeply pigmented.

Z tissue.—For the non-functional late-developing tissue of such nymphs as *Libellula*. They do not possess regular facets and re-

main rudimentary and unpigmented until the end of the nymphal stage.

1. **Experiments on *Aeschna umbrosa*.**—In the eye of a mature nymph of this species only X and Y tissues are present as has already been mentionad. Attention is called to the fact that the part of the Y tissue immediately bordering the budding-zone, although pigmented has never functioned during the nymphal stage. Apparently metamorphosis occurs before it ripens into functional ommatidia.

The dorsal aspect of the nymphal head is shown in Pl. XIII, Fig. 1. The dots record the locations of the punctures pricked on the heads of the different individuals used in this experiment. Figures 2 and 4 illustrate the dorsal and front views of an adult head of this species. Figure 3 is a lateral view of the adult head showing the left eye.

All the dots are labeled with Arabic numerals. All marks which correspond are labeled by the same number, no matter where they appear in these figures.

The record shows the following facts:

1. Scars of all punctures made on the X tissue of the nymphal head appear on the adult head within the area of the big ommatidia.

2. Scars of all punctures made on the Y tissue of the nymphal head appear on the lower lateral portion of the adult eye within the small area of the ommatidia.

3. Scars of all punctures made on the boundary line between the X and Y tissues of the nymphal head appear exactly or approximately coincident with the transitional line of the adult eye. The transitional line of the adult eye in this species is not very distinct, and is deeply curved.

4. Scars of all punctures made on the budding-zone of the nymphal head appear within the area of the small ommatidia of the adult eye, closer to the facial region.

5. Often in this species the longitudinal dark bands of the nymphal eye persist through the metamorphosis. Although only fairly recognizable they serve as excellent landmarks indicating the share which the Y tissue takes in the construction of the adult eye. In the nymphal eye these bands arrange themselves in longitudinal rows, parallel but slightly curved with their concave sides toward the facial region. After metamorphosis the orientation of these bands is altered; the ends of the bands bend away from the facial region.

6. Very often the ruptured cuticle when healing up forms a sharp scar pressing upon the underlying tissue. During the expansion of the eye the scar, being fixed and immovable, scratches the delicate unfolding tissue and thus causes an extended wound which appears later on the adult eye as a linear white scar, as is illustrated in Plate XIII, Figure 2, small, No. 18, and in Plate XVI, Figure 5, small, Nos. 3 and 18.

These facts confirm the following points:

1. The X tissue is destined to form the big ommatidia.
2. The Y tissue, or the functional nymphal eye, is retained as a part of the adult eye in this species. It is within the area of the small ommatidia, constituting the lower lateral portion of the eye—the part which flexed rearward.
3. The main portion of the small ommatidia of the adult eye arises from tissues occupying the budding-zone and the region immediately adjacent to the budding-zone.

4. Great expansion and distortion of tissues occur during the metamorphosis.

2. **Experiments on *Anax junius*.**—Plate XV, Figs. 3 and 4 record the results of experiments on *Anax junius*. In this species the X and Y tissues keep to a distinct boundary line. Punctures were made purposely to cover this dividing line. The results of these trials were very satisfactory. The record shows nothing noticeably different from that of the *Aeschna umbrosa* except that in this species the big and small ommatidia are better differentiated and consequently the transitional line is more distinct.

3. **Experiments on *Gomphus lividus*.**—The nymph of *Gomphus* burrows in the bottom mud and its body structures exhibit many adaptive characters related to this habit. The dorsal aspects of the nymphal head of *Gomphus lividus* are shown in Plate XV, Fig. 7. The antennae appear swollen and conspicuous but each one is reduced to four segments. The bases of the antennae are raised and very broad, occupying a considerable part of the front (B.A.). The tentorial projections are inconspicuous (D.T.). The budding-zone on each side is marked off by grooves and is broader at its posterior end (B.Z.). The facets of the eyes are very well developed in the young nymphs, but development seems subject to the law of use and disuse. In a full grown nymph the eye does not appear to be a very efficient organ; the cuticle is thick and opaque. The facets are exceedingly small in size, those on the side—the older tissues—are better formed but not comparable with those of the Libellulinae. The X tissue appears very late in the

nymphal stage, occupying a small area and is not sharply distinguishable from the remaining parts of the eye; superficially it can only be recognized by its slightly wrinkled cuticle.

The adult eye of *Gomphus* is not excessively large and the two eyes are separated by a wide occipital shelf (Pl. VII, Fig. 1, and Pl. VIII, Fig. 1). The big ommatidia are few in number and are irregularly grouped near the top of the eye. A great gradation of sizes occurs between the few regular big ommatidia and the regular small ones, the transitional line is therefore hardly recognizable.

Puncture No. 1 was made on the side among the better formed facets; No. 2 made on the extreme lateral border of the eye; Nos. 3 and 4 were made on the budding-zone and No. 5 made on the extreme inner margin of the eye (Pl. XV, Fig. 6, small, No. 5 and Fig. 7, small, Nos. 1, 2, 3, 4). The scars of these wounds appear on the adult eye in positions as are marked in Plate XV, Fig. 5, Nos. 1, 2, 3, 4, 5). They were affected by the expansion but the change is apparently not very great. No. 5 moved from the extreme lateral margin inwardly into the eye; this is quite contradictory to the results obtained from species of other groups.

The experiments on this species were done in the spring of 1931. At that time I did not notice the distinction of the different sets of tissues; furthermore, as has just been mentioned, the X tissue in this species is indistinct: therefore, no puncture was made to mark it. However, judging by the position of the scars of the other wounds, there can not be any doubt about the fact that the few irregularly grouped big ommatidia come from the poorly developed X tissue of the nymphal head.

4. Experiments on *Libellula pulchella*.—The head characters of the Libelluline nymph have been discussed in the previous sections. It is only necessary to repeat here that in the eye of a full grown nymph the three sets of tissues, X, Y, Z, are present.

The adult eye of the Libelluline is a wonder of nature. The big and small ommatidia contrast strikingly in sizes and colors. Most of the facets either big or small are regularly six-sided. The transitional line is extraordinarily distinct and is not so deeply curved.

The results of experiments on *Libellula pulchella* are shown in Plate XVI, Figs. 4, 5 and 6. This species is excellent material for this experiment not only because of its large size but also because the different sets of tissues of the eye are very distinctly differentiated. The X tissue is covered by coarse and darkly pigmented

cuticle. The Y tissue forms the definite projecting nymphal eye. The Z tissue is broad and joins the X tissues end to end (Fig. 4, X, Y, Z).

These are the results obtained:

1. Scars of all punctures made on the X tissue appear on the adult head within the area of the large ommatidia.

2. Scars of all punctures made on the budding-zone and Z tissue appear on the area of the small facets which cover almost the entire lower portion of the adult eye.

3. Scars of all punctures made on the boundary line between the X and Y tissues appear quite accurately on the distinct transitional line of the adult eye.

4. Punctures No. 1 and No. 2, made near the center of the Y tissue, appear after metamorphosis on the extreme lateral margin of the adult eye (Fig. 6, scars 1 and 4), indicating that at least half of the nymphal eye has been pushed beyond the boundary of the adult eye.

5. Puncture No. 17 was made in contact with the tentorial elevation. This wound is not retained by the adult eye.

6. Punctures No. 7 and 7a were made close together on the margin of the budding-zone. After the metamorphosis the scars of these two wounds appear to be widely separated (Fig. 6, small numbers 7 and 7a).

7. A fold of membrane is found attaching on the lateral orbit just beyond the eye margin. When treated with KOH the membrane can be removed from the head and spread out like a pocket. It contains facets.

The differentiation of the Z tissue is common to nymphal heads which possess a spoon-shaped labium, but in the Libellulinae the growth of this tissue is particularly pronounced. In this experiment Z tissue gave rise to the majority of the small ommatidia. It seems to indicate that in the higher groups of the Anisoptera the development of the compound adult eye had achieved a more definite scheme. The nymphal eyes complete their growth a considerable length of time before the nymph is mature. The later nymphal life is spent in the development of sets of tissues which are definitely set off to serve the adult life. These late tissues are capable of great expansion, during the metamorphosis they unfold and build up the complete adult eye pushing the nymphal ommatidia quite to the lateral border where they are gradually discarded. The membrane-like fold found on the lateral orbit is the secondary cuticle of the nymphal eye formed during the last instar. It never

gets a chance to develop fully but is pushed out as a fold and attaches itself behind the margin.

5. **Experiments on *Tetragonuria cynosura*.**—The nymphal eye of this Corduline nymph is small, rounded, and projects from the head prominently. The X and Z tissues are both present, they form a long but narrow patch bordering the inconspicuous budding-zone. The boundary line between the Y and Z tissues is not distinct. Plate XVI, Figs. 1, 2 and 3 record the experiment on *Tetragonuria cynosura*. The results agree with those recorded for *Libellula* except:

1. The large and small ommatidia are not so sharply marked off in sizes.

2. The transitional line is indistinct and is sharply curved.

3. The ommatidia of the nymphal eye are not absorbed wholly. The nymphal eye is folded backwards on the lateral border of the adult eye making a jog in the margin; this is the often-noted tubercle on the hind margin of the eye in the Cordulinae. Both facets and pigments are found on the tubercle.

6. **Experiments on *Sympetrum* and *Tramea*.**—The results of the experiments on these two showed no remarkable difference from those recorded for *Libellula*. The nymphal eye is first folded under the adult eye, projecting beyond the lateral border like a tubercle black with pigments, but as the imago matures it is gradually and completely absorbed. This is why in such specialized forms as *Sympetrum* and *Tramea* the lateral border of the adult eye appears to be straight and does not show any trace of the discarded nymphal eye.

The most noticeable difference between the eye features of a mature *Ischnura* nymph and those of the dragonfly nymphs is that in the former there is no external sign of differentiation of tissues. The whole eye is pigmented and its cuticle is thin and transparent. The X and Y tissues such as have been distinguished in the dragonflies do not appear in *Ischnura* nymphs.

Although great expansion of the visual tissue does occur during the metamorphosis, yet all the scars of the wounds I made in my experiments on the nymphal eye of this species appear on the adult eye in similar positions. This shows that the nymphal eye is completely retained by the adult, and that distortions and extensive shiftings of tissue do not occur during the transformation.

In the adult eye of this species, as well as other species of Zygoptera, the ommatidia are not sharply marked off into upper and lower halves by colors and sizes as in the dragonflies. All omma-

tidia are pigmented. Those close to the face are larger and are better formed, while those on the top, lateral and lower sides are comparatively smaller. The change is, however, very gradual, a transitional line like that of the dragonflies is not present.

Summary of Eye Development

1. The eye develops by receiving tissue from the budding-zone, added to the inner margin from instar to instar.

2. The new tissue consists of visual elements which are physiologically imperfect, and require further development to become functionally mature.

3. The late instars give rise to different sets of tissues, some of which may neither show any close affinity with those of the early instars nor exhibit any visual function during the larval stage.

Experiments trace the development of the compound eye during metamorphosis and confirm the destination of the different sets of tissues. The adult eye, especially in the higher forms of Anisoptera, comes from tissues which develop but never function during the nymphal stage.

4. The differentiation of the Z tissue from the Y tissue is most pronounced in the higher Libellulines in which it displaces the Y tissue completely. However, the Libellulidae are a large group, and there is variation among its members. The variation seems to be correlated with the form of the nymphal eye. Plate XVII illustrates roughly four principal types of variation. Figs. 1 and 1a are the front and dorsal aspects of the nymphal head of *Didymops transversa*—a Macromiine. The nymph buries itself in the bottom mud with the tips of the horn-like eyes projecting above the mud; well formed ommatidia are found only on the tips of the eyes. After metamorphosis the nymphal eye is pushed out by the Z tissue, folding backwards beyond the lateral border of the adult eye (Fig. 1b, NE) and is separated from it by a deep groove (g) which is in continuation with the contour of the lateral border of the eye.

In *Tetragonuria cynosura*, a Corduline, conditions are as shown in Pl. XVII, Figs. 2, 2a and 2b. The nymphal eye in this subfamily is small and projects from the head prominently. After metamorphosis, it is folded, as in Macromiine, backwards on the lateral border of the adult eye, making a jog on the margin but it is not separated from the adult eye by a groove (Fig. 2b, NE).

In both Macromiine and Corduline the vestigial nymphal ommatidia are found within the pocket or the jog.

In the higher Libellulines the absorption of the nymphal ommatidia by the adult eye is complete, leaving no trace except the wrinkled membrane (Figs. 4, 4a and 4b).

The absorption, however, is a slow process; thus, in the newly emerged adult the discarded vestige is still apparent as a black projection beneath the membrane but it gradually disappears as the imago grows older.

In the ascending scale, from the lower to the higher forms, there is increasing modification. The improvement is made first by an enormous increase of area and number of the elements, as in *Cordulegaster*; then there is reduction in area and in the number of the elements but improvement in their size and uniformity. The development of the Y tissue is inversely proportional to the development of the X tissue.

The expansion of Z tissue after the metamorphosis in Libellulinae is very striking. It comes to occupy over half of the eye and expels almost the entire nymphal eye at the lateral border. So, the adult eye becomes a new and perfect organ by itself without the participation of the nymphal element.

VII. THE FACETS OF THE COMPOUND EYE

The facets are the corneal lenses of the ommatidia. They constitute the cuticular layer of the compound eye. I have been able to separate the cuticle of the eye of *Pantala flavescens* into six layers. In *Cordulegaster* I found many more, but was not able to find out the exact number. The thick cuticle of the Cordulegasterinae is probably due to the long last stadium the nymph undergoes.

The facets of the nymphal eye when fully formed are regular hexagons showing no difference from those of the adult eye. Those that arise from the older tissue are best developed; they are found on the side of the eye. Those closer to the budding zone are minute and indistinct. In *Gomphus* there are only a small number of larger and even-sided facets, the remainder are small and very poorly shaped. In the Libellulines, although the nymphal eye is small, the facets are more regular and most of them are well formed.

The arrangement and distribution of the facets in the adult eye has been much discussed in the previous sections. In Anisoptera the contrasting sizes of the large and small facets first differentiate them abruptly into two main areas occupying upper and

lower portions of the eye; then within the area of the small facets those derived from the degenerated nymphal eye, if present, distinguish themselves again from the true adult small facets. As a rule the facets, large or small, bordering the margin of the eye are more or less deformed. When the two eyes are confluent along the top of the head as in the Aeschnines and most Libellulines, the facets along the eye seam are not deformed and in some cases they are even the best formed and are largest of all.

I made a one-by-one count of the number of facets in the eye of a few specimens. I found there are 6,925 facets in the adult eye of *Ischnura verticalis*, 7,274 in the adult eye of *Matrona basilaris*, 8,875 in the adult eye of *Ictinus rapax*. I should say that the accuracy of these numbers is at most 95%, because the facets on the margin, especially those on the lateral border, are indistinct. These numbers, however, covered all the distinct and recognizable facets.

I made four measurements of the size of the facets in the species named in the following tables: 1 and 2. Height and width of eye. 3. Number of large facets per millimeter; the measurement was of the largest facets. 4. Number of small facets per millimeter—the measurement was made on the best formed small facets. The 46 species used represent nearly all the principal groups of the Order.

These records show that in Anisoptera the height (dorso-ventral diameter) of the eye is about twice the width (lateral diameter); the average ratio being 1.93.

In Zygoptera the width of the eye about equals the height, the average ratio being 1.217.

The average ratio of size of large and small facets is in Gomphinae, 2.68; in Aeschnines, 1.69; in Cordulegasterines, 1.66; in Macromiines and Cordulines, 1.79; in Libellulines, 2.12; in Zygoptera, 1.31.

In Gomphines the ratio, according to the record, is rather high, due to the fact that in this group the large facets are few and very irregular, and that the measurements of large facets were made to cover only the largest ones.

Within the Libellulines the size of the facets is, to a certain extent, directly proportional to the size of the eye. The small eye has proportionally smaller facets.

MEASUREMENTS OF COMPOUND EYE, AND OF ITS FACETS

Species	Hht of eye	Wth of eye	Ratio	LF N. in 1 mm.	SF N. in 1 mm.	Ratio
<i>Progomphus obscurus</i>	6.5	3.3	1.97	16.0	36	2.25
<i>Ictinus rapax</i>	8.0	5.0	1.60	13.0	29	2.23
<i>Gomphus agricola</i>	4.4	2.8	1.57	11.0	39	3.55
<i>Gomphaeschna furcillata</i>	7.7	3.7	2.08	17.0	28	1.65
<i>Anax parthenope</i>	10.7	5.5	1.95	17.0	28	1.65
<i>Gynacantha subinterrupta</i>	9.83	5.7	1.72	13.5	23	1.77
<i>Cordulegaster dorsalis</i>	9.5	4.8	1.98	19.0	32	1.68
<i>Chlorogomphus infuscatus</i>	11.0	6.0	1.83	15.0	25	1.68
<i>Azuma elegans</i>	12.0	6.3	1.91	13.0	28	2.15
<i>Didymops transversa</i>	6.5	3.3	1.97	21.0	38	1.81
<i>Epicordulia princeps</i>	9.8	5.0	1.96	15.0	25	1.67
<i>Cordulia shurtleffi</i>	7.0	3.5	2.00	21.0	32	1.52
<i>Acisoma panorpoides</i>	4.7	2.5	1.88	22.0	43	1.96
<i>Brachydiplax chalybea</i>	7.6	3.8	2.00	13.5	31	2.38
<i>Brachythemis contaminata</i>	6.4	3.6	1.78	15.5	32	2.13
<i>Brachythemis leucosticta</i>	5.6	3.0	1.86	18.0	38	2.11
<i>Celithemis elisa</i>	6.2	3.2	1.94	15.0	36	2.40
<i>Crocothemis servilia</i>	7.2	3.7	1.94	13.0	38	2.91
<i>Diastatops obscura</i>	4.7	2.6	1.81	28.0	36	1.29
<i>Dielia phaon</i>	7.8	3.9	2.00	16.0	28	1.75
<i>Diplacodes trivialis</i>	5.0	2.7	1.85	17.5	58	2.17
<i>Erythrodiplax minuscula</i>	4.2	2.1	2.00	22.0	44	2.00
<i>Hydrobasileus croceus</i>	9.9	5.1	1.94	14.0	28	2.00
<i>Ladona julia</i>	6.5	3.4	1.91	19.0	35	1.88
<i>Libellula semifasciata</i>	7.5	3.9	1.92	14.0	35	2.50
<i>Leucorrhinia frigida</i>	5.4	3.0	1.80	18.0	38	2.15
<i>Lyriothemis pachygastra</i>	6.6	3.4	1.80	16.0	33	2.06
<i>Neurothemis fulvia</i>	6.8	3.5	1.94	15.0	33	2.20
<i>Orthetrum melania</i>	7.7	3.7	2.08	13.5	29	2.23
<i>Pantala flavescens</i>	8.8	4.3	2.04	16.0	29	1.81
<i>Pseudothemis zonata</i>	8.0	4.0	2.00	15.5	27	1.80
<i>Palpopleura 6-maculata</i>	5.5	2.8	1.96	1.50	36	2.40
<i>Rodothemis rufa</i>	7.3	4.2	1.74	14.0	30	2.14
<i>Rhyothemis fuliginosa</i>	7.1	3.7	1.92	18.0	28	1.56
<i>Ryothemis variegata</i>	7.5	3.7	2.02	17.0	30	1.77
<i>Sympetrum ardens</i>	8.6	4.3	2.00	11.5	29	2.64
<i>Sympetrum corruptum</i>	6.9	3.4	2.03	16.0	32	2.00
<i>Tramea chinensis</i>	9.7	4.7	2.06	13.0	27	2.07
<i>Trithemis festiva</i>	6.8	3.4	2.00	14.0	32	2.08
<i>Pseudophaea opaca</i>	3.8	3.3	1.15	31.0	42	1.36
<i>Taolestes nectans</i>	5.1	4.0	1.27	22.5	31	1.41
<i>Agrion atratum</i>	3.9	3.0	1.30	25.0	34	1.36
<i>Rhinoecypha perforata</i>	3.8	2.7	1.41	27.0	37	1.37
<i>Lestes uncatus</i>	3.1	2.7	1.15	38.0	42	1.11
<i>Argia apicalis</i>	2.9	2.5	1.16	38.0	42	1.11
<i>Platycnemis annulata</i>	3.1	2.9	1.07	30.0	38	1.27

Hht of eye = Height of eye
 Wth of eye = Width of eye
 N. = number

LF = large facets
 SF = small facets

LIST OF ABBREVIATIONS

Abmus.Md	Abductor muscle of mandible	Oc.	Occiput
Abp.	Abductor apodeme of mandible	Oc.F	Occipital foramen
Ad.md	Adductor muscle of mandible	Oc.hn	Occipital horn
Adp.	Adductor muscle of mandible	Oc.shf	Occipital shelf
Ant.	Antenna	Oc.tub	Occipital tubercle
At.	Anterior tentorial arm	Oc. Tri	Occipital triangle
Br.	Brain	ocp.	Occipital process
B.Z.	Budding zone	Oes.	Oesophagus
Adm.	Adductor muscle of maxilla	Pol.	Postocular lobe
Clp;clp;cly	Clypeus	PoS.	Postocular suture
e.	Anterior articulation of mandible	PT.	Posterior tentorial arm
Cwn.	Crown of hypo-labial frame	pt.	Posterior tentorial pit
DT.	Dorsal tentorial arm	SF.or sf.	Small facets
dt.	Dorsal tentorial pit	Sk.	Shank of hypo-labial frame
E.	Compound eye	Mt.	Mentum of labium
Epi.S	Epiceranial suture	Sm.	Submentum of labium
e.	Articulation of maxilla	Smt.pkt.	Small pocket on the base of submentum for the reception of the crown of the hypo-labial frame
er.	Epistomal ridge	t.	Transitional line between the large and small facets
es.	Epistomal suture	TB.	Transverse dark bands of the nymphal eye peculiar character of the Libellulines
F.C.shf	Fronto-clypeal shelf	Tk.mus	Trunk muscle bundles
Fr.or fr.	Frons	Tnt.	Central body of tentorium
Fr hn.	Frontal horn	tra.	Tracheal tube
g.	Condyle for articulation of the cervical sclerites	VV.	Ventral triangular projections of the tentorial body
Ge.	Gena	VK.	Ventral hook of the hypo-labial frame peculiar to the Aeschnines
Hypo.	Hypopharynx	X.	X tissue of the nymphal eye
k.	Trochantin, flexible area between the lower edge of gena and base of mandible	Vx,or vx.	Vertex
Lata	Lateral arm of hypo-labial frame	Y.	Y tissue of the nymphal eye — the pigmented functional nymphal eye
Lb.or lb.	Labium	Ya.	The new tissue of the Y tissue of the last instar; is destined to form the true small ommatidia of the adult eye
LC.	Labial cavity	Z.	Z tissue of the nymphal eye peculiar to the Libelluline nymphs; is destined to form the small ommatidia of the adult eye
LF.or lf.	Large facets		
LgB.	Longitudinal bands of nymphal eye		
Ll.	Lateral lobe of labium		
Lm.or lm.	Labrum		
LO.	Lateral ocellus		
M.	Membrane—2nd cuticle of discarded nym. eye		
Md or md	Mandible		
ML.	Median lobe of labium		
Mth.	Mouth of hypopharyngeal apodeme		
Mx.	Maxilla		
Ne.	Nymphal eye		
Nt.	New tissue of the growing eye		
O.	Median ocellus		
Obt.	Orbit		

PLATE VII

Illustrations of the Principal Types of Odonate Head

(Front aspects)

- Fig. 1. *Gomphus agricola*
2. *Chlorogomphus infuscatus*
3. *Pantala flavescens*
4. *Diastatops obscura*
5. *Anax junius*
6. *Epiophlebia superstes*
7. *Agrion atratum*
8. *Lestes forcipatus*
9. *Platynemis annulata*

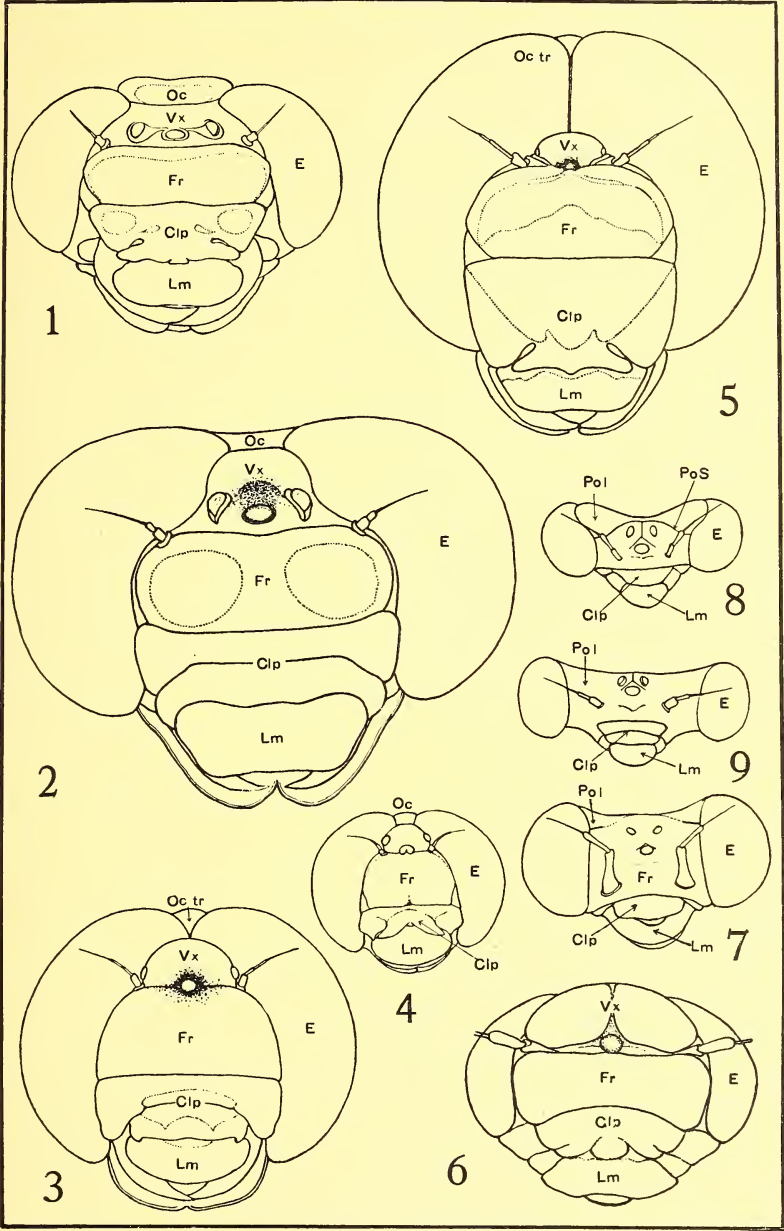


PLATE VIII

Illustrations of the Principal Types of Odonate Head

(Dorsal views)

- Fig. 1. *Gomphus agricola*
2. *Chlorogomphus infuscatus*
3. *Pantala flavescens*
4. *Diastatops obscura*
5. *Anax parthenope*
6. *Epiophlebia superstes*
7. *Agrion atratum*
8. *Coenagrion barbatum*
9. *Gomphus flavicornis* ♀

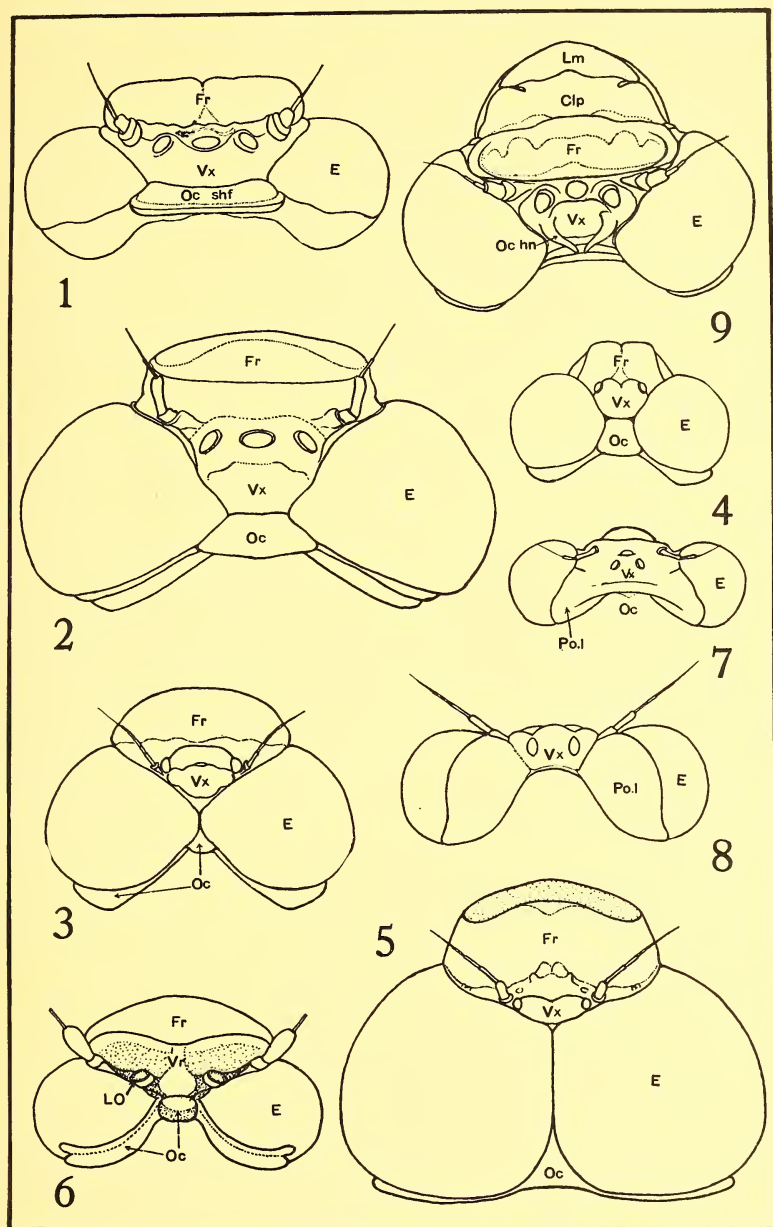
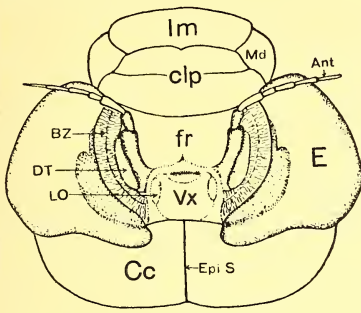


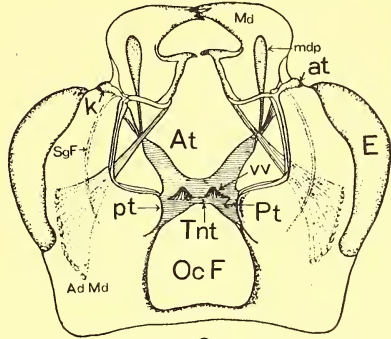
PLATE IX

Illustrations of the Endoskeleton of the Nymphal Head

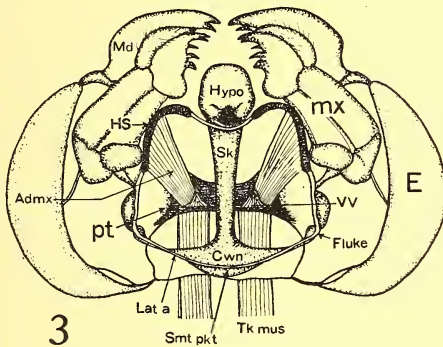
- Fig. 1. Dorsal aspect of nymphal head of *Anax parthenope*, showing the external tentorial elevation (DT).
2. Nymphal head of *Gynacantha subinterrupta*, showing the ventral aspects of the tentorium.
3. Nymphal head of *Gomphus agricola*, showing ventral aspects of the tentorium and the hypo-labial frame.
4. Nymphal head of *Gomphus agricola*, showing dorsal aspects of the tentorium.
5. Hypo-labial frame of *Gynacantha subinterrupta*, showing ventral aspects of the structure.
6. Lateral view of the hypo-labial frame of *Gynacantha subinterrupta*, showing the ventral hook (VK).



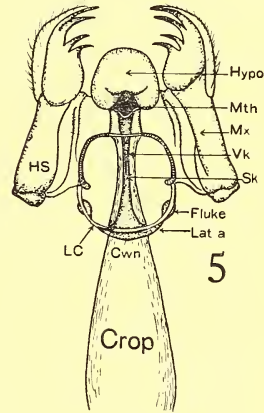
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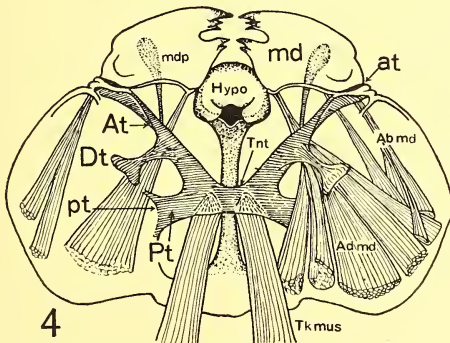
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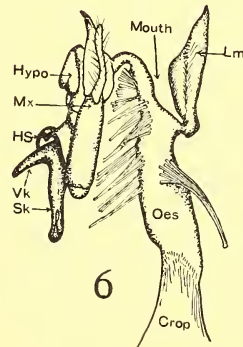
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4



6

PLATE X

Illustrations of the Endoskeleton of the Adult Head

- Fig. 1. Head of *Anax parthenope*, lateral view, showing construction of the orbit.
2. Head of *Pantala flavescens*, showing relative positions of the tentorium (left) and facial sclerites (right).
3. Caudal aspects of head of *Tramea chinensis*, showing the occipital process (Ocp).
4. Head of *Anax parthenope*, showing lateral aspect of the tentorium of the Aeschninae.
5. Head of *Gomphus agricola*, showing front aspect of the tentorium of a Gomphine.
6. Head of *Gomphus agricola*, showing caudal aspect of the tentorium.
7. Head of *Gomphus agricola* sectioned at the mesal line, showing construction of the tentorium, and especially the tentorial body.
8. Lateral view of tentorium, head of *Gomphus agricola* with the compound eye removed.

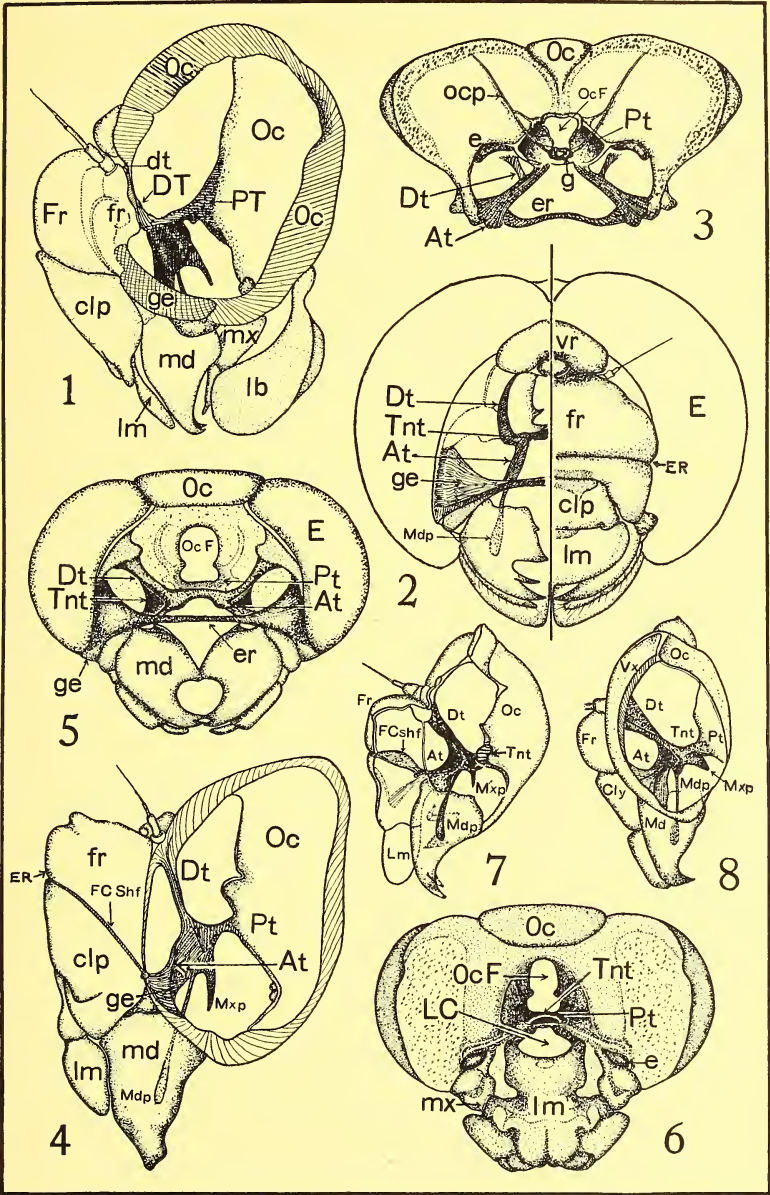


PLATE XI

The Various Forms of the Antennae of Odonata

I. *Antennae of the Nymphs:*

- | | |
|-------------|---------------|
| A. Petalura | E. Platynemis |
| B. Hagenius | F. Rhinocypha |
| C. Gomphus | G. Libellula |
| D. Aeschna | H. Agrion |

II. *Antennae of the Adult:*

- | | |
|--------------------|-----------------|
| 1. Gomphus | 10. Caliaeschna |
| 2. Chlorogomphus | 11. Zonophora |
| 3. Anaciaeschna | 12. Taolestes |
| 4. Tetragonuria | 13. Lestes |
| 5. Hydrobasileus | 14. Coenagrion |
| 6. Nannophya | 15. Platynemis |
| (highly magnified) | 16. Pseudophaea |
| 6a. Nannophya | 17. Hetaerina |
| 7. Anotogaster | 18. Agrion |
| 8. Gomphaeschna | 19. Agrion |
| 9. Epophthalmia | 20. Rhinocypha |

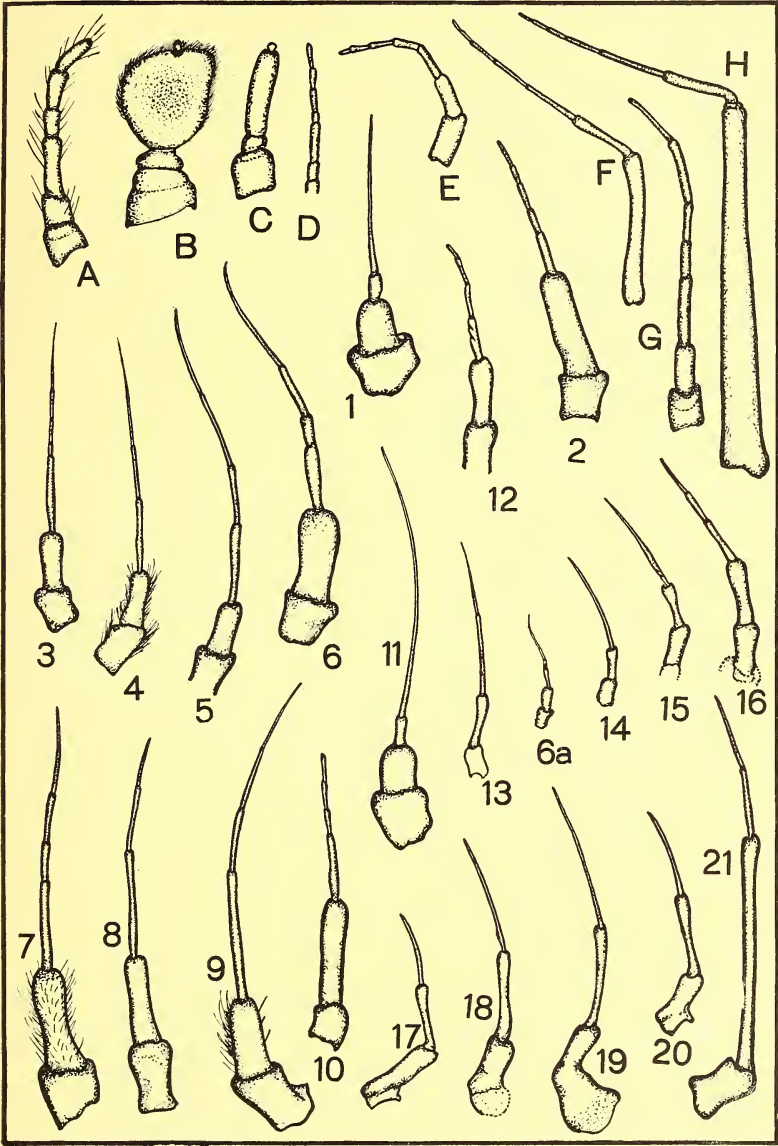


PLATE XII

*Record of Experiment on the Development of the Nymphal Eye in
Five Successive Instars of Aeschna umbrosa*

Figs. 1-4. Drawn from exuviae.

Fig. 5. Drawn from nymphal head.

Small numerals, 1, 2, 3, 4, 5, mark positions of punctures and scars.

X designates the tissue that is destined to form large ommatidia of the adult eye.

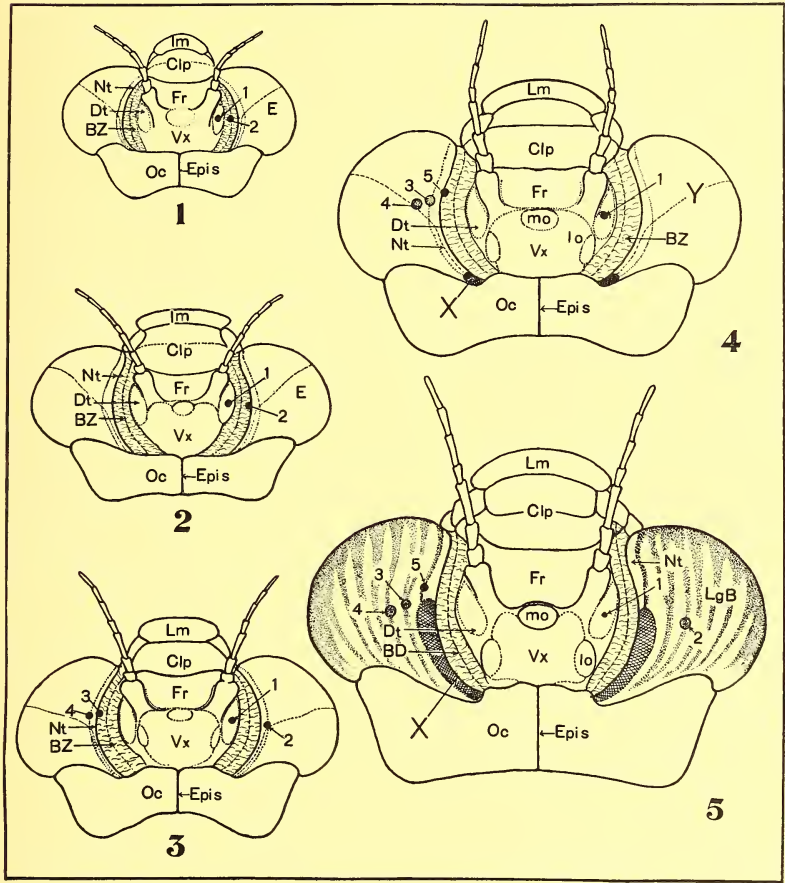


PLATE XIII

*Experiments on the Development of the Compound Eye
During Metamorphosis*

(Aeschna umbrosa)

Fig. 1. Small numerals 1 to 21 record positions of punctures made on nymphal head.

Figs. 2 to 4. Record by the same numbers the positions of the scars of the wounds as they appear on the adult's head.

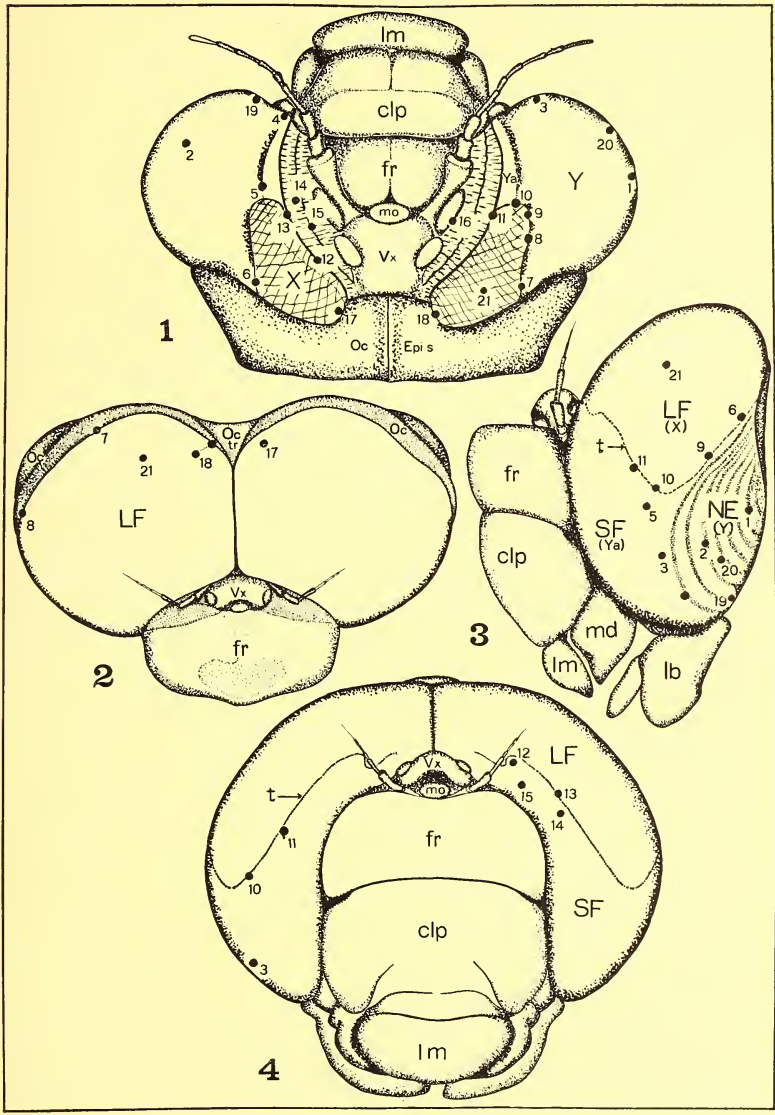


PLATE XIV

*Illustrations of the Principal Types of the Nymphal Head
of Anisoptera*

(Lateral aspects)

- Fig. 1. Pantala
2. Petalura
3. Gynacantha
4. Gomphus
5. Epophthalmia
6. Aeschnophlebia
7. Cordulegaster

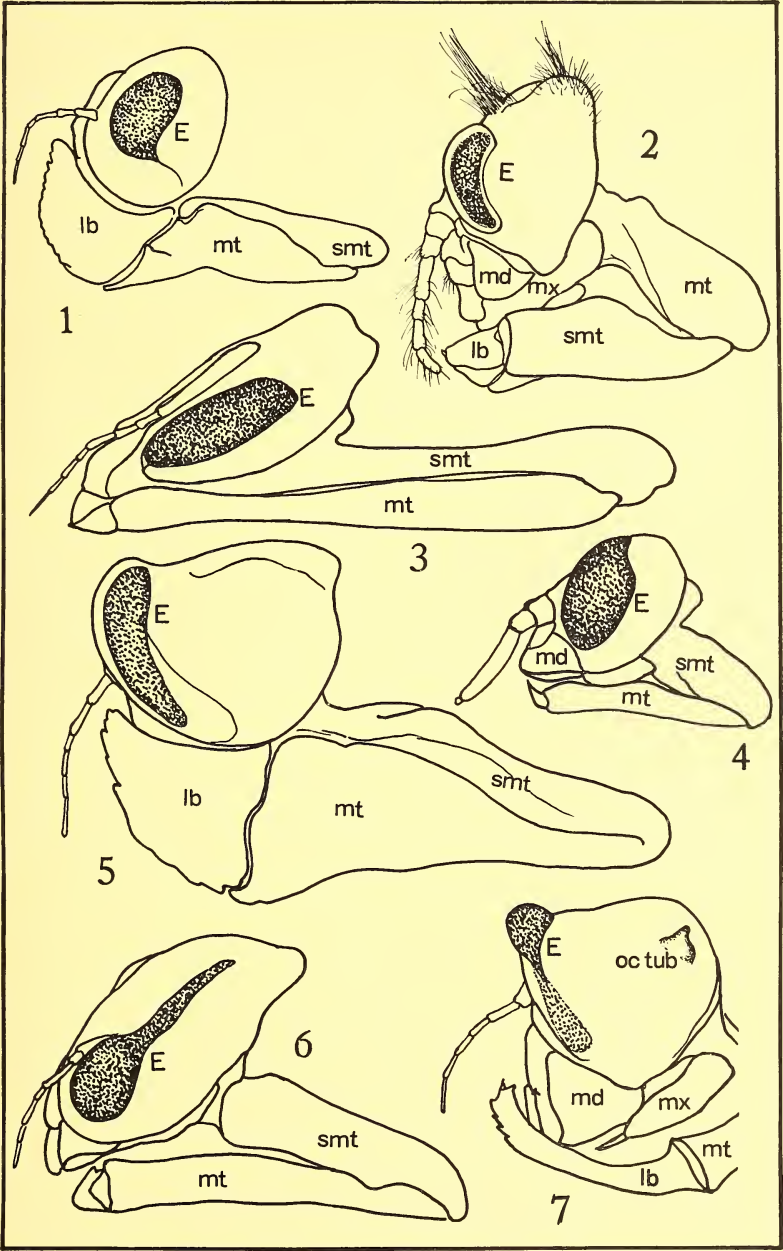


PLATE XV

*Experiments on the Development of the Compound Eye
During Metamorphosis*

I. *Record of Experiment on Anax junius:*

- Figs. 1, 2, 3. The exuviae of the last three instars, showing development of the X tissue.
3. Also records the positions of the punctures made on the nymphal head.
4. Adult head records positions of scars of wounds after metamorphosis.

II. *Record of Experiment on Gomphus lividus:*

- Fig. 5. Adult head of *Gomphus lividus* records positions of scars of wounds after metamorphosis.
6, 7. Nymphal head, showing positions of punctures.

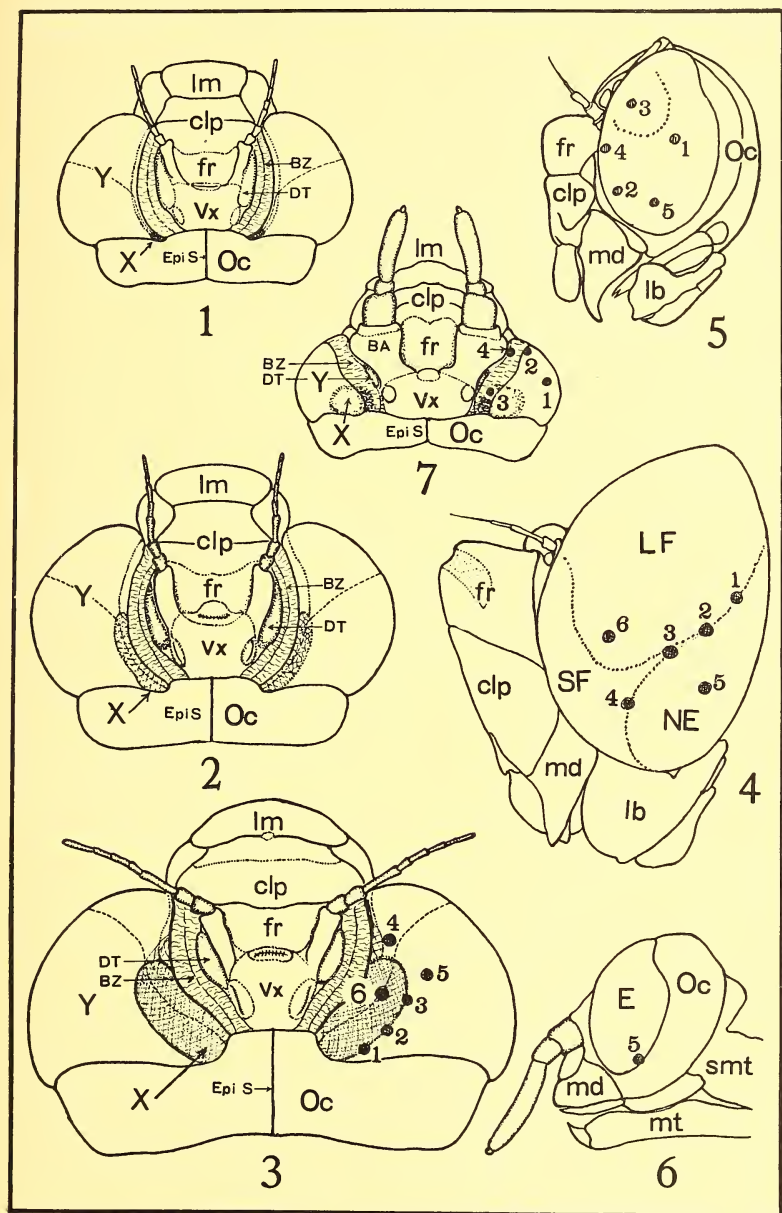


PLATE XVI

*Experiments on the Development of the Compound Eye
During Metamorphosis*

I. *Record of Experiments on Tetragnuria cynosura:*

- Fig. 1. Nymphal head, showing positions of punctures.
2. Lateral aspect of adult head, showing positions of scars of wounds. The Y tissue is pushed to the side, making a jog on the lateral margin.
3. Same, dorsal view.

II. *Record of Experiments on Libellula pulchella:*

- Fig. 4. Nymphal head, showing positions of punctures.
5. Dorsal view of adult head, showing positions of scars of the wounds.
6. Lateral aspect of adult head, showing the same. No. 17, made on the tentorial elevation of nymphal head, is not recovered.

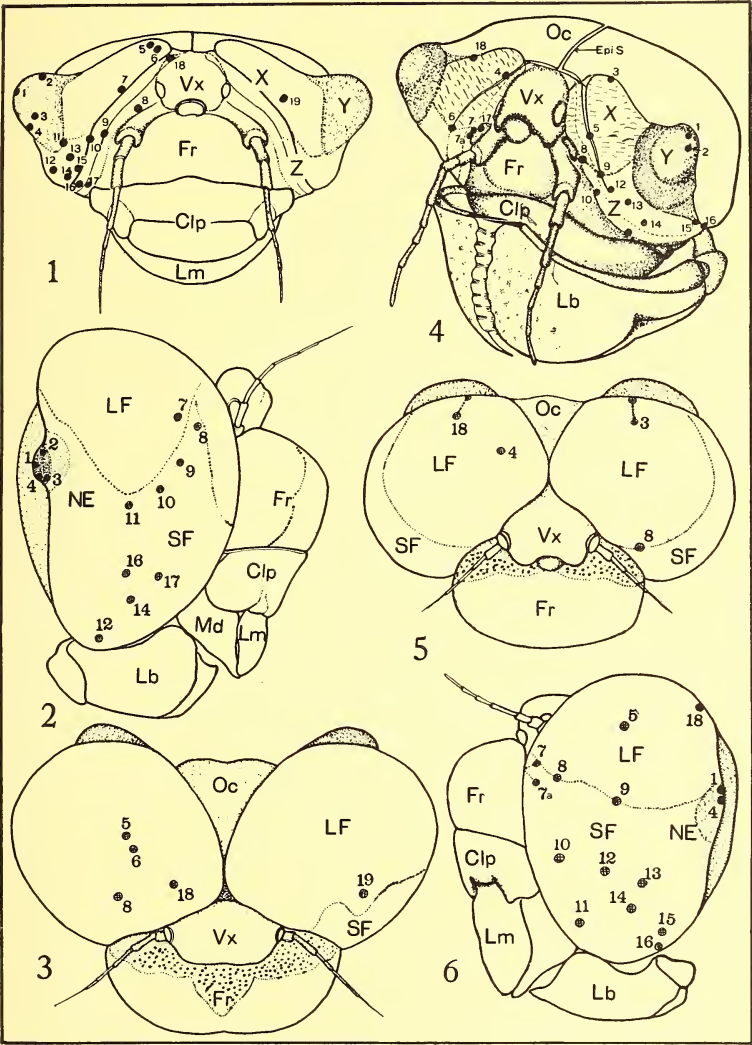


PLATE XVII

Illustrations Showing the Fate of Nymphal Eyes after Metamorphosis in the Different Groups of Libellulidae

Figs. 1 & 1a. Front and dorsal aspects of nymphal head of
Didymops transversa.

1b. Lateral aspect of adult eye.

Figs. 2 & 2a. Front and dorsal aspects of nymphal head of
Tetragonuria cynosura.

2b. Lateral aspect of the adult eye.

Figs. 3 & 3a. Front and dorsal aspects of nymphal head of
Plathemis lydia.

3b. Lateral aspect of the adult eye.

Figs. 4 & 4a. Front and dorsal aspects of nymphal head of
Libellula pulchella.

4b. Lateral aspect of the adult eye.

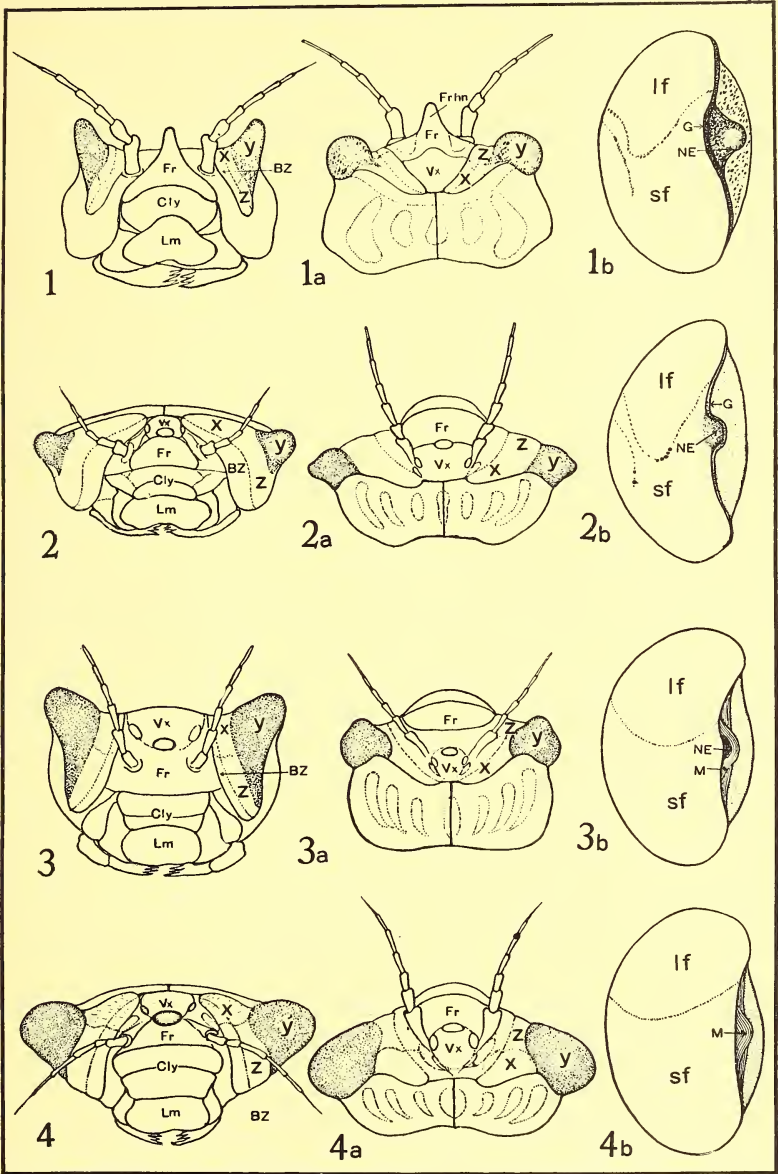
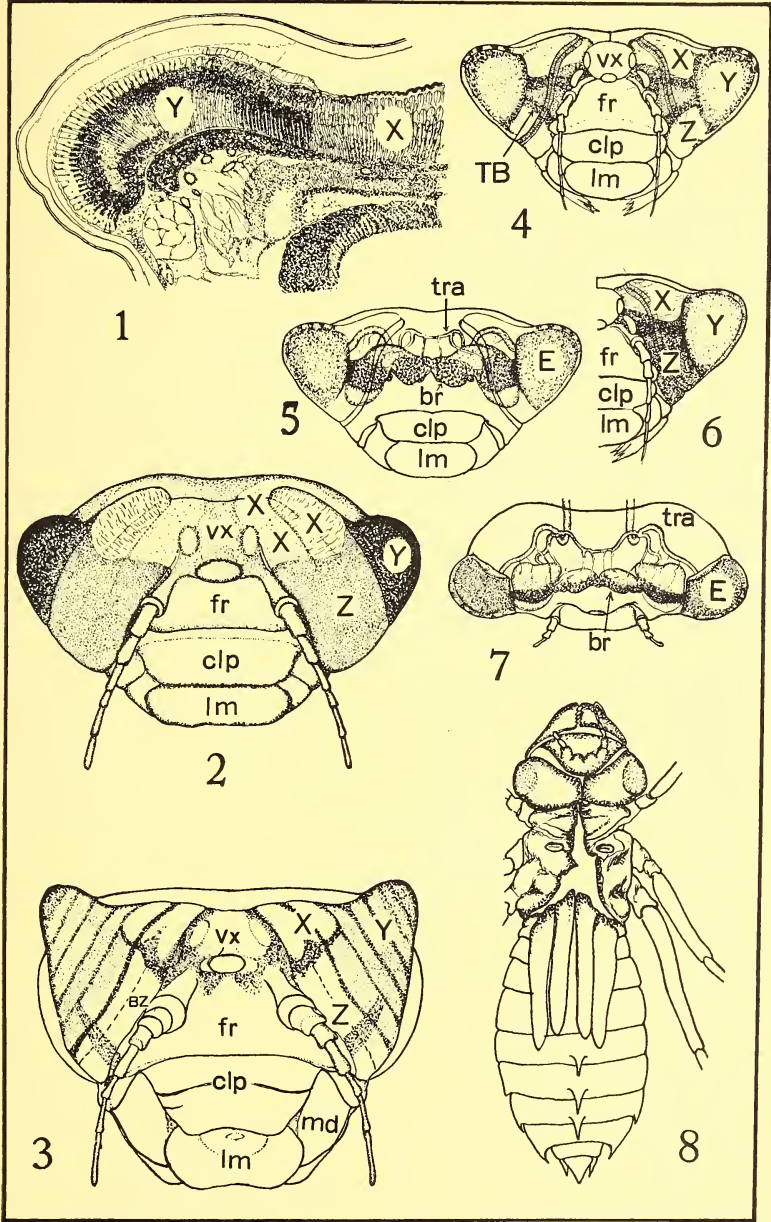


PLATE XVIII

Features of the Mature Nymphal Head of Libellulines

- Fig. 1. A cross section of mature nymphal head of *Sympetrum vicinum*, showing X and Y tissues and the post-retinal layer.
- Fig. 2. Fully mature nymphal head of *Mesothemis*, showing the expansion of the X tissue (X, X, X) shortly before metamorphosis.
- Fig. 3. Head of mature nymph of *Plathemis lydia*, showing the longitudinal pigment bands, the transverse bands and the X, Y, Z tissues.
- Fig. 4. Head of mature nymph of *Sympetrum vicinum*, showing transverse bands (TB) and X, Y, Z tissues.
- Fig. 5, 6. Nymphal head of *Sympetrum vicinum*, showing tracheation and pigments of the surface of the brain.
- Fig. 7. Dorsal view of the same.
- Fig. 8. Exuvium of Libelluline, showing the cleft of the molting on the thorax and head, particularly of the eye region.



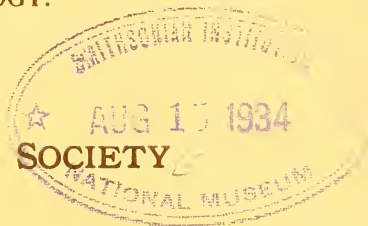
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No. 3

A REVIEW OF THE NORTH AMERICAN SPECIES OF AGATHIDIUM (COLEOPTERA; SILPHIDAE)

BY H. C. FALL, TYNGSBORO, MASS.

A recent critical survey of the *Agathidium* material in my collection has revealed the presence of a considerable number of undescribed species. There is nothing surprising in this fact when it is recalled that the last published treatment of the genus was that of Dr. Horn in his Silphidae paper of more than fifty years ago. Since that time only four additional species have been described, viz: *A. virile* Fall (Occ. Papers Cal. Acad. Sci. VIII, 1901), and *A. maculosum* (1928), *A. canadensis* (1930), and *A. conjunctum* (1933) by W. J. Brown, all in the Canadian Entomologist.

While the chief incentive to the present paper has been to make known the new species that have come to my attention, it has been thought best in the interest of completeness to amplify the work by including short descriptions or pertinent notes on the old species as well, and to prepare a new tabular synopsis of all our known fauna.

The various external structural modifications within the genus are in the main accurately noted and sufficiently described by Horn in his preliminary remarks. It should be said however that the membranous border of the clypeus is subject to individual variation, at least in some species, and in an extreme case has been observed to be either distinct or apparently lacking in different examples of the same species.

That Horn was not very assiduous in his search for external sexual characters is evident from his statement that "sexual char-

acters other than those found in the tarsi do not occur except in *dentigerum*." As a matter of fact such characters are almost universally present. A very common sexual mark is the presence of a bristle bearing fovea or erosion on the metasternum of the male. This structure however is sometimes very small and inconspicuous and in general would be quite concealed by the usual type of mounting, and hence easy to overlook.

In the pursuance of my investigation I have carefully studied at the Museum of Comparative Zoology in Cambridge the types and other material in the Le Conte collection, which includes also types or typical examples of several of Mannerheim's species; also the Blanchard and Bowditch collections now contained in the same museum. The Blanchard collection, always notable for the condition and careful mounting of its specimens, deserves especial mention in that it furnished no less than four undescribed species in this genus, all of which were taken by Blanchard himself in the White Mts., in New Hampshire.

To Mr. Chas. Liebeck, of Philadelphia, I am again indebted for valuable notes on certain of the Horn types and for the opportunity of studying his entire *Agathidium* material; moreover he has most kindly allowed me to retain the types of three new species contained in his cabinet. For aid in the way of specimens or information I am very grateful to a number of correspondents, notably Mr. C. A. Frost and Mr. Henry Dietrich: acknowledgment of such will be made in the proper places.

All types of new species are in the writer's collection unless otherwise stated.

TABLE OF SPECIES OF AGATHIDIUM

1. Mesosternum subhorizontal throughout and carinate in front, the intercoxal process not or but little oblique 2
Mesosternum steeply inclined to nearly vertical between the coxae, becoming horizontal and more or less broadly roof shaped anteriorly but not distinctly carinate 9
2. Metasternum each side with an oblique ridge or raised line; body very strongly contractile 3
Metasternum without oblique ridge, body rather feebly contractile 4
3. Elytra seemingly impunctate under moderate power.
 - a. Third antennal joint distinctly longer than the second.
 - b. Sutural stria either wanting or not attaining the middle of the elytra.
Sutural stria very fine, confined to the apical

third of the elytra; size large (3 to 4 mm.);
color black when mature. (Eastern U. S.).
oniscoides Beauv.

Sutural stria slightly longer but rather feebly
developed; size small, a little over 2 mm.
(fully extended); color reddish brown.
(North Carolina).....**rubellum** n. sp.

Sutural stria wanting; piceous; length 2.5 mm.
(extended). (North Carolina; New Hamp-
shire).....**compressidens** n. sp.

bb. Sutural stria extending fully to the middle of the
elytra, average length about 2 mm.

exiguum Melsh.

aa. Third antennal joint not or barely perceptibly longer
than the second; sutural stria wanting.

Form very convex; upper surface highly polished;
metasternum very short.....*dentigerum* Horn.

Form only moderately convex; entire upper surface
alutaceous, the elytra most conspicuously so; meta-
sternum of male of normal length. (Alaska.)

alutaceum n. sp.

Elytra distinctly punctulate, otherwise nearly as in *exiguum*.

californicum Horn.

4. More elongate oval, the elytra conspicuously longer than wide
and more or less attenuate posteriorly; prothorax usually
distinctly wider than the elytra; elytral punctures showing
a more or less evident tendency toward a serial arrangement
in longer or shorter lines at some portion of the disk.....5

More broadly oval, elytra but little longer than wide and not
appreciably attenuate; prothorax scarcely or but very
slightly wider than the elytra; elytral punctures showing
little or no trace of serial arrangement (except *revolvens*).... 6

5. Form very much depressed; antennal club piceous; metasternal
fovea of male small, circular (Alaska; Alberta; Illinois;
Montreal)**depressum** n. sp.

Form less depressed; antennal club rufotestaceous like the
stem.

Metasternal fovea of male rather large and transverse.

jasperanum n. sp.

Metasternal fovea of male minute, punctiform.

dubitans n. sp.

6. Elytra each with several impressed lines occupied with serial
punctures*revolvens* Lec.

Elytra almost without trace of impressed lines or distinct series
of punctures 7

7. Metasternum of male concave anteriorly in about middle third, the concavity polished and bearing a transverse series of fine erect hairs; hind femora of male toothed on posterior margin at some distance from the apex; size large (3 mm. not fully extended). (British Columbia) *cavisternum* n. sp.
Metasternum not concave anteriorly; tooth of hind femur of male apical or nearly so in position 8
8. Metasternal fovea or erosion of male tranverse, rather large and conspicuous. (California) *virile* Fall.
Metasternal fovea of male very small, punctiform. (British Columbia; Washington) *conjunctum* Brown.
Metasternal fovea of male apparently lacking. (Glacier Park, Montana) *omissum* n. sp.
9. Left mandible not modified in the male 10
Left mandible of male either prolonged or bearing an erect horn; clypeal emargination with more or less distinct membranous border; body very convex and contractile 19
10. Hind angles of thorax quite sharply defined, subrectangular; protarsi of female 4-jointed 11
Hind angles of thorax rather well defined, their vertices however more or less narrowly rounded 13
Hind angles of thorax broadly rounded 18
11. Oblong oval, not very convex, scarcely at all contractile, black, thorax red, elytra each with six slightly impressed series of coarse punctures, the intervals also distinctly punctate.
sexstriatum Horn.
Broadly oval, convex, moderately contractile 12
12. Piceous, elytra each with two (sometimes more) feeble more or less abbreviated rows of punctures *bistriatum* Horn.
Piceous, thorax orange red, elytra irregularly punctate throughout *estriatum* Horn.
13. Head with distinct postocular tempora, which when viewed from the front are nearly as long as and a little more prominent than the eyes; elytral punctures unusually fine and numerous; clypeal suture not impressed *angulare* Mann.
Head narrowed immediately behind the eyes; clypeal suture more or less distinctly impressed 14
14. Size small (about 1.3 mm. not extended), color entirely rufo-testaceous; clypeus not emarginate and without visible membranous border, clypeal suture finely impressed; hind angles of thorax somewhat defined; ventral segments each with a single or nearly single transverse row of punctures.

Entire upper surface almost completely impunctate; pro-
tarsi of female 4-jointed. (Lake Superior; Maine).

parvulum Lec.

Elytra very sparsely finely punctulate with tendency
toward linear arrangement. (California).

parile n. sp.

Size larger (1.75 to 2.25 mm.), color black or piceous; ventral
segments irregularly punctured.....15

15. Head distinctly alutaceous and somewhat dull, finely and
sparsely but distinctly punctate.....*rusticum* n. sp.

Head polished, more numerous but very minutely and less
distinctly punctulate.....16

16. Antennal stem rufotestaceous, club piceous; size smaller (about
1.75 mm.).

Clypeal margin not retracted, the edge very narrowly pale
but apparently without membranous border; 3rd an-
tennal joint slender, narrower than the 2nd, twice as
long as wide and as long as the two following united;
elytral punctuation strong, completely confused.

laetum n. sp.

Clypeal margin retracted and with rather wide mem-
branous border; 3rd antennal joint stout, not narrower
than the 2nd, less than half longer than wide and
shorter than the two following united; elytral punc-
tures finer and in part serially arranged.

contiguum n. sp.

Antennae entirely rufotestaceous; size larger (2.25 mm.).....17

17. Metasternum finely and sparsely punctate.

athabascanum n. sp.

Metasternum less finely and quite densely punctate, especially
at middle.....*alticola* n. sp.

18. Sutural stria normal; head with prominent postocular tem-
pora; size rather large, color rufotestaceous to piceous, sur-
face not alutaceous, elytra coarsely punctate. (Pacific
Coast).....*coccinum* Mann.

Sutural stria normal, head without postocular tempora.

columbianum n. sp.

Sutural stria wanting, surface not alutaceous, virtually im-
punctate.....*rotundulum* Mann.

19. Metasternum at middle extremely short; upper surface com-
pletely impunctate; elytra without sutural stria; size very
small, length but little over 1 mm. (California).

brevisternum n. sp.

Metasternum of normal length.....20

20. Protarsi of female 5-jointed 21
Protarsi of female 4-jointed; elytra very convex.
a. Sutural stria present; metasternum alutaceous, nearly or quite impunctate.
b. Color black or piceous.
Upper surface virtually impunctate.
atronitens n. sp.
Upper surface of elytra very distinctly punctate; sutural stria finer than usual.
repentinum Horn.
bb. Color entirely rufotestaceous; surface sparsely minutely punctate *politium* Lec.
aa. Sutural stria wanting; color testaceous with black markings; surface evidently though finely punctate.
maculosum Brown.
Elytral punctures fewer and still finer than in the typical form, and almost confined to the middle of the disk, where they are serially arranged.
maculosum var. *franciscanum* n. var.

21. Postocular tempora present 22
Postocular tempora undeveloped, the head narrowed immediately behind the eyes 23

22. Entire upper surface numerous finely punctate; size large, elytra more than 2 mm. long *temporale* n. sp.
Head and thorax nearly impunctate; size smaller, elytra 1.3 to 1.7 mm. long.
Elytra rather sparsely but very distinctly punctate; metasternum rather densely punctured *assimile* n. sp.
Elytra very sparsely minutely punctulate; metasternum more finely less closely punctured *mollinum* n. sp.

23. Hind angles of thorax more or less broadly rounded 24
Hind angles of thorax well defined 25

24. Color generally testaceous or reddish, the thorax with median piceous spot, the elytra with the suture, discal spots and lateral margin piceous; or by diffusion the color may become predominantly piceous, the elytra with lateral paler spots of variable extent; terminal joint of antennal club pale; surface distinctly punctate *pulchrum* Lec.
Color black or piceous, antennae and legs blackish, side and rear margins of thorax diffusely paler; hind angles of thorax less broadly rounded, somewhat defined *picipes* n. sp.

25. Head and thorax piceous, margins of latter diffusely paler, elytral disk rufous with large blackish scutellar triangle; head unusually strongly and conspicuously punctate.

difforme Lee.

Agathidium oniscoides Beauv.

This common eastern species, though varying much in size, is on the average the largest in our fauna. Oddly enough the smaller specimens are nearly always females. It is highly polished and under low power appears to be "completely impunctate" as described by Horn. Under a $\frac{1}{4}$ inch triplet however it is seen to be minutely punctulate throughout the upper surface. The sutural stria is shorter and finer than usual and quite characteristic of the species. In the male the hind thighs are more widened apically than in the female and are distinctly angulate on the posterior margin at the knee; there is also in this sex a tuft or pencil of erect hairs arising from a shallow depression on the median line and near the hind margin of the metasternum.

Occurs generally throughout the Eastern States from Canada to Georgia and west to Iowa and Arkansas.

Agathidium rubellum n. sp.

Body very contractile, rather broadly oval, moderately convex, reddish brown to rufotestaceous throughout, upper surface polished and virtually impunctate. Clypeus with more or less evident membranous border, elypeal suture obliterated. Antennae entirely pale, 3rd joint longer than the 2d and subequal to the next two united; 7th joint very little longer but not wider than the 8th. Hind angles of thorax broadly rounded, completely undefined. Elytra obliquely narrowed in basal two-fifths, the angle rounded and very obtuse; sutural stria fine, lightly but evidently impressed apically, completely disappearing some distance behind the middle. Metasternum impunctate, finely alutaceous at sides, polished at middle. Hind thighs rather stout, with a more or less defined angle at the outer condyle. In the material at hand females have not been recognized and it is impossible to say whether this character is a sexual one.

In the male the tarsal formula is 5-5-4, and the basal joints of the protarsi are slightly dilated; in this sex also there is a very small bristle bearing puncture at about the middle of the polished median area of the metasternum.

Length (fully extended) about 2 mm. or slightly more.

Five examples of this species have been sent me by Mr. Liebeck, who had referred them to *dentigerum*. They are all from North

Carolina without more definite locality, and all are of the same color and of nearly uniform size. The tabular characters are sufficient to separate them from any related species. In assigning the specific name *rubellum* it is assumed that the color is normal and not due to immaturity.

***Agathidium compressidens* n. sp.**

Body strongly contractile; broadly oval, moderately strongly convex, piceous, surface polished and impunctate. Clypeus broadly emarginate, with membranous border; clypeal suture not detectable. Antennae rufous, first two joints of club darker, terminal joint paler, 3d joint distinctly longer than the 2d and as long as the two following united; 7th plainly wider and longer than the 8th. Thorax slightly wider than the elytra, hind angles somewhat indicated though broadly rounded. Elytra as wide as long, humeri oblique, sutural stria wanting. Mesosternum sharply carinate and horizontal in front, a little oblique between the middle coxae. Metasternum with distinct oblique ridge each side, transversely strigoso-alutaceous laterally but without punctures, smooth at middle. Hind thigh slender; tarsal joints (♀) 5-4-4.

Length (extended) 2.5 mm.

At the base of the intercoxal process of the first ventral segment there is a small erect and somewhat oblique laminiform or compressed tooth. This may or may not prove to be a secondary sexual character of the female; I have seen nothing like it in either sex of any other species.

Described from two female specimens, one received from Mr. Liebeck and bearing label "White Mts., N. H., woods," the other (selected as the type) in my collection from Round Knob, North Carolina, received many years ago as *dentigerum*, which indeed it greatly resembles superficially. It is definitely separable from *dentigerum* by the 3rd antennal joint distinctly longer than the 2nd, and by the metasternum at middle being of nearly normal length.

***Agathidium exiguum* Melsh.**

Closely allied and very similar to *oniscoides* but much smaller, averaging in length from 2 to 2.5 mm. when more or less extended. The punctuation of the upper surface is very fine, somewhat variable, but usually a little more apparent than in *oniscoides*; the sutural stria is about twice as long as in the latter and much

coarser. The metasternum of the male is provided with a similar tuft of erect hairs, which in this case is more nearly at the middle of its length. The hind thighs are not materially different in the sexes.

Exiguum inhabits the same region as *oniscoides* but its range is somewhat more extended if the reported locality "Colorado" is correct.

Agathidium dentigerum Horn.

Black or piceous, margins of thorax diffusely rufescent, beneath including antennae and legs brown or reddish brown. The size is rather small (2 mm. or a little more fully extended), the body perfectly contractile. Surface smooth and polished, quite impunctate, and without sutural stria. The 2nd antennal joint is rectangular, slightly wider and just perceptibly longer than the 3rd, strictly speaking a unique character. The hind femur of the male is armed with a triangular tooth near the outer condyle.

The above set of characters are quite sufficient to distinguish this species from any other in the genus; however it possesses another all but unique feature in that the metasternum is extremely short at middle so that the middle and hind coxae are almost in contact. This character was overlooked by Horn and I have observed it elsewhere only in the very small *brevisternum* n. sp., which belongs to a wholly different section of the genus. I have seen no females of *dentigerum* but Horn says they have the slender tarsi with 5-4-4 formula and simple hind femora characteristic of females in general.

Dentigerum was described from a single pair taken by Schwarz at Stone Creek, Lee Co., Virginia. There is a single male bearing this label in the Le Conte collection, the location of the original female is unknown to me. Mr. Liebeck writes that neither of the original types are now in the Horn collection. I have seen a number of specimens taken by Schwarz at Round Knob, N. C., and others from Black Mts., N. C., collected by Beutenmuller.

Agathidium alutaceum n. sp.

Body very strongly contractile, rather broadly oval and moderately convex; piceous, antennae and legs paler, entire upper surface very finely alutaceous and sparsely minutely punctulate under the strongest hand lens; head and thorax moderately shining, the elytra slightly less so because of the more obviously alutaceous surface. Clypeal margin just visibly retracted and with perceptible membranous border;

clypeal suture invisible. Antennae reddish brown, the terminal joint slightly paler; 3rd joint very slightly longer than the 2nd and barely as long as the two following united, 7th and 8th transverse, not very unequal. Hind angles of thorax completely undefined, sides continually arcuate with the base. Elytra as wide as long, evidently narrowed basally but without lateral angle; sutural stria wanting. Metasternum finely alutaceous, a little smoother at middle, punctures few and fine, oblique ridges rather feeble. Hind tarsal joints (♀) 5-4-4.

Length 2.25 mm. (thorax raised but head deflexed).

Described from a unique female specimen with locality label "Alaska," received from Mr. Liebeck.

Among the few species without sutural stria this one is unique in its entirely alutaceous upper surface.

Agathidium californicum Horn.

Among the species of the first limited group, *viz.*, those possessing the oblique metasternal ridge, this is the only one in which the elytra show an evident punctuation under moderate or low power. The head and thorax appear to be impunctate, but under higher amplification are seen to be minutely alutaceous with scattered extremely fine punctures. In almost every other respect agrees nearly with *exiguum*, the characters of which need not be here repeated. Just behind the middle of the metasternum in the male there is a shallow pit or impression bearing short erect hairs.

This species is said by Horn to occur in "California, Nevada and Washington Territory." It is represented before me by several examples from Salmon Arm, British Columbia, sent by Mr. Hugh B. Leech, a specimen from Fresno Co., Cal. (Dietrich), and a single male in my own collection from Lake Tahoe, California.

Agathidium depressum n. sp.

Form much depressed, elongate oval, distinctly attenuate posteriorly, body only feebly contractile. Color piceous, thorax usually more or less rufous especially around the margins, the elytra often becoming gradually rufous or rufescent at apex. Antennae rufous, club piceous, 3rd joint a little longer than the next two, 7th very distinctly both longer and wider than the 8th. Clypeal margin truncate, just perceptibly retracted and with distinct membranous border; clypeal suture very fine, detectable but not impressed. Entire upper surface shining, not at all alutaceous, everywhere numerous punctate; the punctures of the head

and thorax rather fine, those of the elytra coarser and closer, with here and there a tendency toward a serial arrangement. Prothorax perceptibly wider than the elytra, hind angles broadly rounded; elytra very plainly elongate and gradually narrowed from near the base; sutural stria long, extending to the basal third or fourth. Body beneath piceous, legs reddish brown. Mesosternum a little oblique between the coxae, horizontal and carinate in front. Metasternum horizontal, alutaceous, sparsely punctate, oblique lateral ridge wanting. Tarsal formula 5-5-4 (♂), 5-4-4 (♀).

In the male there is a small round bristle bearing fovea near the middle of the front margin of the metasternum, the basal two joints of both fore and middle tarsi are very distinctly dilated, and the rear margin of the hind femur is distinctly angulate at its outer extremity; not so in the female.

Length (extended but head vertical) 2.8 to 3.25 mm. In the type the dimensions of the elytra are—length 2.2 mm., width 1.75 mm., the thorax slightly wider than the elytra.

The type is a male collected at Terrace, British Columbia, by Mrs. W. W. Hippiusley and kindly given me by Mr. C. A. Frost. Other localities represented before me are Seward, Alaska, VI-15-1911 (W. S. McAlpine), 1 ♀; McKinley Park, Alaska, July 8, 1924, one pair (♂ ♀) collected by the writer; Edmonton, Alberta, 1 ♂, (F. S. Carr); Montreal and Rigaud, Quebec, 1 ♂, 3 ♀s, sent by Mr. Liebeck. A single female example from Urbana, Illinois (C. P. Alexander, May 1, 1921), sent by Mr. Frost, is doubtfully referred. It is a little less depressed than the typical form but scarcely differs otherwise; the male when found may show it to be distinct.

There are under *revolvens* in the Le Conte collection two "Cal." examples which seem to belong to this species, and it is probable that others will be found so placed in various collections.

This and the following seven species constitute a compact and well defined group, which while possessing with the preceding group the subhorizontal mesosternal intercoxal process, is characterized by the absence of the oblique metasternal ridge, the generally less convex form and low degree of contractility; the metasternum is long, horizontal, alutaceous and usually more or less subrugulose; the 3rd antennal joint longer than the two following united; the upper surface distinctly punctate throughout. The species are very generally referred to *revolvens* in collections and this name may appropriately be applied to the group.

Agathidium jasperanum n. sp.

Very similar to the preceding species, the description of which applies equally well here except in the following par-

ticulars. The size is slightly smaller on the average than in *depressum*, the form noticeably less depressed when viewed in profile; antennae entirely rufous, the club not appreciably darker than the stem; the metasternal fovea of the male much larger and transversely oval in form. The color is about the same, the upper surface piceous, the thorax usually rufescent, but the elytral apex scarcely so.

Length 2.5 to 3 mm., width about 1.7 mm.

The type series comprises four examples, all taken by the writer, *viz.*—Jasper Park, Alberta, August 4, 1924 (2♂, 1♀); White Horse, Yukon Territory, June 21, 1924 (1 ♀). The type is a male from the first named locality.

Agathidium dubitans n. sp.

Elongate oval, moderately convex, form distinctly less depressed than in *depressum* and nearly as in *jasperanum*. Color above piceous, the thorax broadly diffusely rufescent around the margins, legs and antennae throughout rufous. Upper surface shining, non-alutaceous and punctured as in the two preceding species. The elytral punctures are more or less serially arranged and some of the longer lines are very faintly impressed in certain lights. The hind angles of the thorax are broadly rounded, the elytra evidently elongate and feebly attenuate.

In the male the metasternum bears a very small punctiform setiferous fovea in the usual antero-medial position, the basal joints of the fore and middle tarsi are perceptibly dilated, and the terminal angle of the hind thighs is sharply defined, a little obtuse.

Length (partly extended) of type 2.9 mm., width of thorax 1.6 mm.

Described from a single male specimen from Clouderoft, New Mexico, and bearing date June 9–12. The metasternal fovea in the unique type is so minute as to easily escape notice. Because of the limited amount of material available for study it is not yet possible to say to what extent this metasternal fovea of the males may vary individually within the species. For the present it is assumed to be substantially constant.

Agathidium revolvens Lec.

This species was described from a unique female specimen from the north shore of Lake Superior. Several other examples from different regions were later placed with it in the Le Conte collection

but none of these is closely in accord with the type nor have I as yet seen a specimen that could safely be so referred. The following description drawn from the type is sufficiently full for comparative purposes.

Form broadly oval, moderately convex, semicontractile. Above piceous black, shining; legs and antennae entirely rufous. Clypeus truncate, very feebly retracted, with membranous border; clypeal suture not impressed, barely detectable. Third joint of antennae subequal to the next three, seventh joint only just perceptibly larger than the eighth. Head and prothorax finely sparsely punctate; elytra comparatively coarsely and closely so and with several perceptibly impressed lines occupied by serial punctures. Prothorax not distinctly wider than the elytra, hind angles broadly rounded, scarcely defined; elytra very little longer than wide, humeri oblique with well defined obtuse angle. Metasternum horizontal, alutaceous and sparsely punctate, without oblique ridge.

Length (extended) 3.4 mm.

Revolvans is distinctly more broadly oval with less elongate elytra than in the three preceding species, in which moreover the serially arranged punctures nowhere occupy perceptibly impressed lines.

With the exception of my *A. virile* (Occ. Papers, Cal. Acad. Sci. VIII, 1901) and *A. conjunctum* recently described by Mr. W. J. Brown (Can. Ent. 1933, p. 46) the somewhat numerous closely allied species of this group have not hitherto been differentiated but have been referred indiscriminately to *revolvans*. In my Alaskan paper (Pan Pac. Ent. Jan. 1926) the McKinley Park and White Horse specimens which I recorded as *revolvans* belong respectively to *depressum* n. sp. and *jasperanum* n. sp. of the present paper.

Agathidium cavisternum n. sp.

Broadly oval, moderately convex, piceous black, shining, sides of thorax and elytral apex brunnescent. Clypeal margin slightly retracted and with narrow membranous border; clypeal suture undefined. Antennae entirely rufotestaceous, 3rd joint as long as the next three, 7th a little longer but scarcely wider than the 8th. Prothorax not distinctly wider than the elytra, hind angles broadly rounded. Elytra very little longer than wide, sides oblique for a short distance at the humeri, with distinct obtuse angle. Head and thorax sparsely fine punctate, elytra more coarsely and closely punctured, with faint indications of one or two impressed lines;

sutural stria attaining the middle. Metasternum alutaceous and sparsely punctate at sides, smooth with a few finer punctures at middle. Legs reddish brown, hind thighs rather coarsely and numerous punctate.

In the male the metasternum becomes abruptly declivous and concave anteriorly in about the middle third, and with a transverse line of erect hairs within the concavity. In this sex also the basal joint of the protarsus is unusually strongly dilated, the 2nd joint and also the basal joint of the middle tarsus less evidently so; hind thighs with a broad but sharply defined tooth at some distance from the apex. In the female the metasternum is horizontal throughout, the tarsi and hind femur unmodified.

Length (type ♂) 3.25 mm.; two females are somewhat smaller.

Described from four examples, three of which including the type were collected at Terrace, British Columbia, by Mrs. W. H. Hipsley and submitted by Mr. C. A. Frost, who kindly permits me to retain the type: the latter bears labels "IV-8-1924" and "sifting moss." The fourth example is a male from Stickeen River Canon, B. C., collected by Wickham and submitted by Mr. Liebeck, to whom it is returned.

This species is probably the nearest one of the group to the true *revolvens*, it being the only one to show faint traces of the impressed elytral lines which characterize that species. If the male of *revolvens* when found should prove to possess the pronounced and in part unique sexual characters of the present species, their identity could not be doubted.

Agathidium virile Fall.

Rather broadly oval, moderately contractile; piceous black, sides of thorax diffusely paler; legs and antennae entirely reddish brown; surface polished and sparsely finely punctate, the elytra a little more coarsely so. Third antennal joint as long as the three following, seventh and eighth subequal. Prothorax scarcely wider than the elytra, hind angles rounded. Elytra perceptibly longer than wide, not at all attenuate, sides obliquely narrowed at the humeri, sutural stria strong, extending in front of the middle; surface without trace of impressed lines and virtually without serially arranged punctures. Metasternum alutaceous and subrugulose, sparsely punctate.

In the male the basal joints of pro- and mesotarsi are distinctly dilated; the posterior margin of hind thighs is con-

cave and with a moderately strong dentiform angle at the outer extremity; the metasternal fovea varies somewhat in size, is near the anterior margin, transversely oval, and bears a line of short hairs, which in the type is interrupted in the middle.

Length about 2.5 mm. (head deflexed), about 3 mm. fully extended.

Southern California. The type is a male collected by the writer at Pomona, March 25, 1893. Other examples are from Riverside and Pasadena. With the above are placed in my collection a number of specimens from Middle California (Alameda; Berkeley; Belmont; Santa Cruz), some of which differ in having the antennal club infuscate; these are probably not specifically distinct.

Agathidium conjunctum Brown.

Broadly oval, moderately convex and contractile; black, pronotal sides and legs dark reddish brown. Antennae rufous, club somewhat darker; 3rd joint as long as the three following, 7th slightly but distinctly longer and wider than the 8th. Hind angles of thorax broadly rounded. Elytra very slightly longer than wide, sides broadly rounded to apex, not at all attenuate. Head and thorax finely but distinctly punctate, elytra less finely so, not at all substriate, scutellar stria attaining the basal fourth. Clypeal, sternal and tarsal structure as in other species of the group.

Length of type (extended) 3.4 mm., width 2 mm.

This species was described by Mr. W. J. Brown (Can. Ent. 1933, p. 46) from a single male taken at Langdon, British Columbia, March 7, 1931 (K. Graham). The hind thighs are described as "widened apically, with a tooth on the lower posterior margin near the apex, the tooth moderate in size, wide at base, acute at apex." The description states that the metasternum is "without a fovea and hair tuft near the middle of the anterior margin," but in answer to my request that he confirm this statement Mr. Brown writes that "the bristle bearing pit is present; it is very small and punctiform."

In my own collection two examples (♂, ♀) from Seattle, Wash., and also two from "W. T." and one from Nevada submitted by Mr. Liebeck, are confidently referred to this species.

Agathidium omissum n. sp.

Oval, moderately convex and contractile; piceous black, sides of thorax and apex of elytra brunnescent; legs dark

rufous, antennae paler rufous, the club not darker. Antennae with 3rd joint as long as the three following, 7th joint slightly larger than the 8th. Upper surface strongly shining, punctures of head and thorax sparse and fine, of elytra a little coarser. Elytra perceptibly longer than wide, oval, not attenuate; sutural stria deep, attaining the basal fourth, otherwise without trace of impressed lines or serial punctures. Metasternum alutaceous, feebly rugulose, and sparsely punctate.

Length (type, fully extended) 3 mm.; width of elytra 1.5 mm., of thorax 1.6 mm.

The unique type is a male, taken at Glacier Park, Montana, July 10, 1929, by Miss Edith Mank, who has kindly presented it to me. This male shows no detectable setiferous metasternal fovea, the basal joint of both fore and middle tarsi is conspicuously dilated, the second joint perceptibly so; the hind thighs are concave on their posterior margin, the outer extremity with a sharply defined tooth.

This is the only species of the *revolvens* group thus far known (male of *revolvens* not known) in which the male is not characterized by the presence of the bristle bearing fovea. Should its absence prove to be accidental rather than specific there would be little if anything to separate *omissum* from *conjunctum*.

Agathidium sexstriatum Horn.

The tabular characters constitute a quite sufficient diagnosis of this unusually distinct species. As there indicated it is the first of a series of four species having the hind angles of the thorax sharply defined and subrectangular and the protarsi of the female 4-jointed. The 8th antennal joint is distinctly wider than the 7th, both strongly transverse; the clypeus is slightly more advanced than the sides of the front, without membranous border, the clypeal suture traceable but not impressed. The elytra are distinctly longer than wide in about the ratio of five to four. The mesosternum is elevated just before the middle coxae in a thin transverse process with rounded summit; metasternum not alutaceous, numerous rather strongly punctate. In the male the four anterior tarsi are distinctly dilated, and the metasternum shows in advance of the middle two transversely arranged shallow erosions bearing golden yellow hairs.

Length (extended) 2 mm. or a little more.

Occurs in Western Nevada and the adjacent regions of California.

Agathidium bistriatum Horn.

Broadly oval, convex, semi-contractile, piceous, moderately shining. Clypeus rufous, without membranous border, clypeal suture finely impressed. Antennae brownish red, the first two joints of the club a little darker, the terminal joint paler; 7th and 8th joints progressively wider and strongly transverse. Head finely punctate; thorax scarcely visibly so except under high power; elytra conspicuously punctate, each with two or more incomplete rows of larger punctures on the disk. The elytra are scarcely longer than wide, humeral angles sharply defined and a little obtuse; sutural stria moderate. Mesosternal intercoxal area produced upward (as viewed inverted) in a thin transverse plate with rounded summit, the same as in *sexstriatum*; metasternum not alutaceous, finely punctate at sides, smoother at middle posteriorly.

In the male the protarsi are moderately dilated, the mesotarsi only feebly so; the metasternum as in *sexstriatum* is provided with two ante-median shallow erosions bearing short erect yellow hairs.

Length about 2.5 mm.

Described from Western Nevada. I have in my collection an example from Lassen County in Northeastern California, collected by Nunenmacher.

Agathidium estriatum Horn.

Broadly oval, convex, semi-contractile, piceous, shining, thorax rufous. Clypeus a little advanced beyond the sides of the front, truncate, without membranous border, clypeal suture finely impressed. Terminal joint of antennae a little paler, 8th joint wider than the 7th. Prothorax sparsely minutely punctulate, hind angles sharply subrectangular. Elytra slightly longer than wide, moderately densely rather finely punctate, the punctures somewhat unequal to size. Metasternum very finely alutaceous and evenly rather sparsely finely punctate; a small bristle bearing fovea before the middle in the male.

Length about 2.5 mm.

This species was described from a single male specimen from Garland, Colorado (Schwarz).

There are now two Garland, Col., specimens in the Horn collection (*fide* Liebeck), and the Le Conte collection contains a single male from the same locality; this last the only example of the species I have been able to study. Although Horn had not seen the

female he apparently assumed that it would have 4-jointed protarsi because of its natural association on other grounds with species having this character.

Agathidium angulare Mann.

Broadly oval, more evidently attenuate than usual, moderately convex; color dark brown or piceous, the thorax inclining to be more or less rufescent. The clypeal margin is a little retracted and with membranous border; clypeal suture traceable but scarcely impressed. Antennae rufous, the club darker, 7th and 8th joints strongly transverse, subequal. The sides of the head instead of being subparallel or obliquely narrowed immediately behind the eyes as in all the preceding species, are here a little swollen so as to be as prominent or a little more so than the eye itself. The hind angles of the thorax are somewhat defined but with rounded vertices. The entire upper surface is very finely but rather densely punctulate, the punctures on close attention showing considerable inequality in size. Metasternum alutaceous and finely punctate, and in the male there is before the middle a minute punctiform fovea bearing one or two short erect bristles. The fore and middle tarsi of the male are moderately dilated.

Length 2 to 3 mm.

Horn's diagnosis was evidently drawn from the two specimens of this species in the Le Conte collection. One of these, from Sitka (the type locality), bears a foreign number "93" and is in all probability from Mannerheim; the other is from Veta Pass, Colorado, and presumably collected by Schwarz; it appears to be identical with the Alaskan specimen. In my own collection are examples from Washington State ("W. T."), Tuolumne Meadows, Cal., and Mohawk, Cal. (Fenyès). I have also placed tentatively with these two entirely rufotestaceous specimens, a male from Plumas Co., California (Nunenmacher) and a female from "Arizona." In these last the antennae are entirely pale.

The most important characters of this species are the postocular tempora and the unusually dense punctulation. I observe in my own specimens referred to *angulare* that the antennal club is unusually large, and that in certain examples at least the funicular joints are bristling with numerous short erect hairs. I could not test out this last character in the Alaskan example from Mannerheim because of the gummed up condition of the antennae.

Agathidium parvulum Lec.

Le Conte's unique type of this species was judged by Horn to be merely a small specimen of *politum*. In this he was in error, as a careful examination of the type reveals numerous important differences. *Parvulum* is smaller and even more convex than *politum*; the surface is quite impunctate, the left mandible of the male is not at all modified, the clypeus is not emarginate and is without membranous border, the clypeal suture is finely impressed, the hind angles of the thorax are somewhat defined, and the ventral segments are provided each with only a single row of punctures extending from side to side; in all of which respects it differs from the true *politum*. The size in *parvulum* is very small, about 1.3 or 1.4 mm.; the color is entirely rufotestaceous; the 7th and 8th antennal joints are very strongly transverse, the 8th fully twice as wide as long, the 7th a trifle wider and thicker than the 8th; the metasternum is finely alutaceous at sides, smooth at middle and virtually impunctate; in the male there is a well defined erosion with erect hairs before the middle.

Le Conte's unique type is a male from Marquette, Lake Superior. Besides this I have seen but one other specimen, a female, in the Blanchard collection at the Cambridge Museum. This female shows the tarsal formula 4-4-4.

Agathidium parile n. sp.

Very small, length about 1.4 mm., strongly convex, entirely rufotestaceous; surface highly polished, very sparsely finely punctulate, the punctures most evident on the elytra, where they exhibit an obvious tendency to arrangement in rows. The clypeus, clypeal suture, antennae, hind angles of thorax, metasternal and ventral sculpture, are almost precisely as in *parvulum*. As in *parvulum* also the humeral angle is sharply defined and a little obtuse, and the sutural stria is moderately deep and attains the middle of the elytra.

Described from two male specimens collected by Dr. Fenyès at Sugar Pine, California. These show a minute punctiform bristle bearing fovea on the median line of the metasternum in advance of the middle.

Agathidium rusticum n. sp.

Broadly oval, moderately strongly convex, piceous. Head rather strongly alutaceous and finely but distinctly punctulate; thorax minutely alutaceous with scattered very fine punctules; elytra non-alutaceous, distinctly sparsely punctate.

tate, the punctures here and there showing a serial arrangement. Antennae rufous, outer five joints piceous; 7th joint wider than and nearly twice as thick as the 8th. Clypeal margin virtually level with the sides of the front and with extremely narrow membranous border; clypeal suture strongly impressed. Hind angles of thorax well defined, a little obtuse. Metasternum finely alutaceous at sides, smooth at middle, punctures sparse and unevenly distributed. Before the middle of the metasternum in the male is a transverse linear erosion bearing a row of about eight erect setae; the female has not been seen.

Described from two male specimens, of which the type in my own collection is from the White Mountains, New Hampshire, and bears label "Crawford Notch, 7-25-08." The second example, furnished by Mr. C. A. Frost, is labelled "Holliston, Mass., V-5 or 18, 1923 (J. H. Emerton)."

The most notable feature of this species is the distinctly alutaceous head, the thorax being very feebly alutaceous and the elytra not at all so.

Agathidium laetum n. sp.

Moderately broadly oval, strongly convex; head and elytra piceous, thorax rufopiceous; integuments polished; head and thorax sparsely very finely punctulate, elytra sparsely but very distinctly strongly confusedly punctate. Antennae rufous, club piceous; 3rd joint much more slender than the 2nd, twice as long as wide and as long as the two following, 7th and 8th subequal and strongly transverse. Clypeal margin not retracted, feebly arcuate, continuous with the sides of the front, margin very narrowly pale; clypeal suture impressed. Hind angles of thorax a little obtuse, defined, but with vertices narrowly rounded. Elytra oval, distinctly longer than wide, humeral angle sharply defined, somewhat obtuse; sutural stria strongly impressed, attaining the middle of the elytra. Metasternum not alutaceous, and with a few scattered punctures. Tarsal formula of female 5-4-4.

Length (not extended) about 1.75 mm.

Described from two female specimens taken by the writer at Pasadena, California, one bearing date 4-15-05.

This species agrees with the preceding in a considerable number of features but is easily separable by the tabular characters. In addition to the points there mentioned the rufescent thorax and non-alutaceous metasternum in *laetum* are probably also distinctive.

Agathidium contiguum n. sp.

Oval, moderately convex, piceous, margins of thorax pallescent; integuments shining; head and thorax minutely obsoletely punctulate; elytra less finely and more distinctly punctate, with evident tendencies toward serial arrangements. Antennae rufous, club piceous; 3rd joint as wide as the 2nd, less than one-half longer than wide and shorter than the two following united; 7th and 8th transverse, the former a little thicker but scarcely wider than the 8th. Clypeal margin retracted and with wide membranous border; clypeal suture impressed. Hind angles of thorax somewhat defined but with rounded vertices. Elytra perceptibly wider than the thorax and a little longer than wide, humeri obtusely but sharply angled; sutural stria moderate. Metasternum very finely alutaceous, finely sparsely punctate. In the male the metasternum shows a transverse arcuate scratch or erosion before the middle, in which is a series of about nine fine punctures which probably bore fine erect setae, but these have now been lost.

Length (extended) about 1.8 mm.

Described from a male specimen from Washington State ("W. T.") sent by Mr. Liebeck. With this I place a female example also sent by Liebeck, from Seattle, Wash. This latter scarcely differs from the type except in being entirely rufotestaceous and in having the terminal joint of the antennae paler; its tarsal formula is 5-4-4, that of the male 5-5-4.

Agathidium athabascanum n. sp.

Rotundate oval, strongly convex; piceous brown, legs, antennae and ventral segments reddish brown. Upper surface entirely without alutaceous sculpture, strongly shining; head and thorax with very obscure minute punctulation, which is almost invisible except under a strong lens; elytra finely but distinctly uniformly punctate, without any tendency toward serial arrangement. The 7th antennal joint is triangular, only slightly transverse, 8th a little shorter but subequal in width to the 7th. Clypeal margin not retracted and with pale coriaceous border; clypeal suture impressed. Hind angles of thorax defined, a little obtuse, their vertices narrowly rounded. Elytra very nearly as wide as long; sutural stria moderate. Metasternum finely alutaceous and sparsely finely punctate; male with an antemedian very small punctiform bristle bearing fovea.

Length (not extended) 2 mm.; width 1.5 mm.

Described from a unique male specimen taken by the writer at Jasper Park, Alberta, Aug. 4, 1924.

***Agathidium alticola* n. sp.**

This species is so completely in accord with the preceding except in the one tabular character—the punctuation of the metasternum—that it seems not worth while to repeat the description. In *athabascanum* the metasternum is sparsely finely punctate and without a defined impunctate area along the rear margin. In the present species the metasternum is densely a little less finely punctate over the entire surface excepting a narrow sharply defined area on either side along the posterior margin but not attaining the outer angle, which is entirely impunctate.

The proper description of the clypeal margin is somewhat uncertain. In the male type there appears to be a well defined membranous border; in another example this border seems quite lacking, and in others the appearance is intermediate. A similar situation has been observed in certain other species, it being at times difficult to distinguish between a true membranous border and a mere pale more or less coriaceous edge of the clypeus itself. In the female the tarsal formula is 5-4-4.

Length 2 to 2.25 mm.

Six examples of this species have been seen, all bearing the label "White Mts., N. H., subalpine, July 1, 1896," and probably all collected by Frederick Blanchard from whom I received my pair.

***Agathidium concinnum* Mann.**

Rotundate oval, moderately convex, color varying from rufotestaceous to piceous, surface strongly shining, not at all alutaceous. Head very finely punctulate, thorax equally finely but more sparsely and very indistinctly so, elytra relatively quite coarsely not densely punctate. Antennae either entirely rufous or with the club darker; 7th joint a little larger but scarcely wider than the 8th. Clypeal suture impressed. Hind angles of thorax broadly rounded. Elytra very little longer than wide, humeral angle rounded, sutural stria strong. Metasternum alutaceous, distinctly punctate; male with a punctiform bristle bearing fovea before the middle.

Length averaging about 2.5 mm.

This is perhaps the commonest *Agathidium* of the Pacific Coast, ranging from Southern California to Alaska. Two examples from Colorado (Breckinridge and above Ouray, collected by Wickham) have been sent by Mr. Liebeck.

Horn describes the clypeus as entirely corneous. This is probably true but in many specimens the edge is narrowly pale, simulating a membranous border; in one example the pale margin is wider than usual and has all the appearance of being truly membranous. In several males in the series before me there is a minute denticle near the middle of the rear margin of the hind femur; other males show no trace of this and I am as yet unable to discover any correlated characters which permit of making a division into two species. The prominent tempora at once distinguish this species from its nearest relatives and constitute its most important character.

***Agathidium columbianum* n. sp.**

Broadly oval, moderately convex; piceous, the sides of the thorax diffusely, and antennae and legs paler; entire upper surface polished; head and thorax minutely sparsely punctulate, the elytra rather sparsely but very distinctly so, the punctures showing no trace of serial arrangement. Head without post-ocular tempora; clypeus entirely corneous, arcuately more prominent at middle than the sides of the front; clypeal suture impressed. Hind angles of thorax broadly rounded. Elytra perceptibly longer than wide, humeri rounded, sutural stria well impressed. Metasternum alutaceous and distinctly punctate; male with a punctiform bristle bearing fovea before the middle.

Length (body somewhat extended) 2 mm.

Described from a single male specimen taken at Terrace, British Columbia, by Mrs. Hippisley, and kindly given me by Mr. Frost.

This species is without any marked peculiarities of structure and is to be recognized by the combination of tabular characters. The antennae are not clearly visible as mounted.

***Agathidium rotundulum* Mann.**

Globose oval, strongly convex and contractile; piceous, margins of body often paler; feet and antennae rufous, the antennal club piceous. Surface strongly shining, absolutely impunctate, elytra without sutural stria. Clypeus not at all retracted, truncate at middle, entirely corneous; clypeal suture not impressed, traceable only in certain lights. Hind angles of thorax broadly rounded. Beneath sparsely punctulate; metasternum of normal length.

Length 1.5 mm. (body contracted), 2 mm. (fully extended).

Described from Alaska. There is in the Le Conte collection a supposedly typical example from Mannerheim bearing number "95." This is doubtless one of the two specimens from Mannerheim from which Horn says he drew his description. Mr. Liebeck's collection contains two examples from Vancouver. I have in my own collection a specimen from the Santa Cruz Mts., California, which agrees in all visible characters with the one from Mannerheim. Both specimens are so mounted that it is impossible to determine their sexual characters.

The small size, impunctate surface and lack of sutural stria easily distinguish this species from any other in this part of the genus except *brevisternum*, which is even smaller and has the horned left mandible in the male, and an extremely short metasternum.

Agathidium brevisternum n. sp.

Form globose, very convex and strongly contractile; color reddish brown to castaneous, paler beneath; upper surface shining and absolutely impunctate. Antennae entirely pale, 3rd joint elongate cylindrical, 7th oval, rather longer than wide, 8th oval and a little transverse. Clypeus truncate, with or without evident membranous border; clypeal suture not impressed. Hind angles of thorax feebly defined, vertices rounded. Elytra a little wider than long, humeri rounded, sutural stria wanting. Metasternum very short at middle. In the male the basal joints of the four anterior tarsi are slightly dilated as usual, and the left mandible is armed with a moderately long erect curved horn.

Length (body contracted) barely 1 mm.

Described from a single pair kindly given me many years ago by Mr. Schwarz, from a series collected by Mr. H. S. Barber at Eureka, California. The type is a male and bears date 24th of May.

This minute species is easily recognizable in the group having the left mandible prolonged or horned, by its size, absolutely smooth upper surface, and lack of sutural stria.

Agathidium atronitens n. sp.

Globose oval, very convex, black or piceous, upper surface polished and impunctate. Antennal stem rufous, first two joints of club piceous, terminal joint paler; 2nd joint slightly longer than the 3rd, 7th and 8th moderately transverse and subequal. Clypeal suture completely undefined.

Hind angles of thorax only feebly defined, their vertices rather broadly rounded. Elytra as wide as long; humeri rounded; sutural stria moderate. Metasternum alutaceous and almost or quite impunctate. Tarsal formula of female 4-4-4.

Length (not extended) about 2 mm.

To this species belong the piceous examples included by Horn under *politum*. Horn observed that the dark specimens were "absolutely smooth" while the pale ones were "microscopically punctulate." Further study would have revealed that the dark form is perceptibly more convex and that in it the 3rd antennal joint is barely as long or even slightly shorter than the 2nd, while in the pale form the 3rd joint is distinctly longer than the 2nd as is usual. Horn states that the protarsi of the female are five jointed, whereas in both *politum* and the present species there are only four joints in this sex.

Only two examples of the present species are before me; the type, a female from Urbana, Illinois, in my own collection, and a male from the District of Columbia sent by Mr. Liebeck. In this male the left mandible is distinctly prolonged but not horned; the bristle bearing fovea of the metasternum is probably present but is invisible as mounted. Mr. Liebeck writes that the specimens of this species in the Horn collection are from the District of Columbia and Missouri.

Agathidium repentinum Horn.

The following is Horn's description. "Oval, convex, contractile, piceous, shining. Head sparsely punctulate, clypeus prolonged at middle, truncate at tip and corneous. Thorax more than twice as wide as long, hind angles broadly rounded, surface sparsely punctulate. Elytra oval, very little longer than wide, humeri oblique forming a distinct angle with the sides, sutural stria extremely fine but attaining the middle, surface very distinctly punctate. Body beneath sparsely punctate. Length 2 mm."

I give as a valuable addition to the above the following notes submitted by Mr. Liebeck after a careful examination of the type. "The color of the elytra, most of the head, and antennal club is piceous; the base of the head at middle, antennae except the club, thorax, tip of elytra and the entire under surface is reddish brown, the latter of varying shade; entire upper and under surface alutaceous. Clypeal suture fine and distinct, the front third of the clypeus pale and sharply defined but corneous like the remainder.

The punctures of the head are fine and separated by rather more than their own diameters; clypeus at base with coarse punctures which gradually become smaller to the limited pale area which is impunctate. The antennae are rather short, 2nd joint almost globular, 3rd cylindric and but little longer, 4th and 5th not transverse almost quadrate, 6th slightly and 7th and 8th decidedly transverse. The thoracic punctures are finer than those on the head. Elytra very convex, notably high for the size; the sutural striae are distinct when viewed from above toward the apex, sharply defined and not impressed each side as with many other species. Probably Dr. Horn used the expression 'extremely fine' because the groove is sharply limited on the flat surface without any noticeable impression each side. The elytral punctures are coarser and more distinct as compared to those of head and thorax, dense at sides, where they are separated by their diameters or less, somewhat finer and more widely spaced on the disk and still finer toward the apex."

Horn's description was drawn from a unique female specimen taken by Frederick Blanchard in the "White Mountains, New Hampshire, woods."

Not having seen an example of *repentinum* an inquiry addressed to the National Museum brought a reply from Mr. W. S. Fisher that they had in their collection four examples of a species from Bear Paw Mt., Montana, which had thus been referred by Schwarz. Two of these specimens, a male and female, were sent me for examination and I in turn sent the female to Mr. Liebeck for comparison with the Horn type. He reports that the Montana specimen agrees well in all essential features with the type and that he "feels safe" in assuring me of their specific identity.

If this be the case it becomes necessary to shift the position of *repentinum* in the table to the group having the left mandible of the male horned, since in the Bear Paw Mt. male the left mandible is thus armed. In the Bear Paw Mt. female the protarsi are quite surely four jointed. Horn failed to state the number of protarsal joints in his unique female type and Mr. Liebeck writes that he is unable to determine the number with certainty.

Agathidium politum Lec.

Broadly oval, moderately strongly convex, rufotestaceous; surface apparently impunctate but with a strong lens minute punctules can be seen scattered sparingly over the elytra, and detectable with more difficulty on the thorax.

Antennae entirely pale, 3rd joint distinctly longer than the 2nd. Clypeal margin a little retracted, the membranous border narrow and varying in distinctness; clypeal suture traceable but not impressed. Hind angles of thorax broadly rounded. Elytra slightly longer than wide, humeral angle obtuse, indicated but with rounded vertex; sutural stria rather long, distinct. Metasternum alutaceous, virtually impunctate; a punctiform bristle bearing fovea in the male in the usual position before the middle. Left mandible of male either prolonged or with an erect curved horn. Protarsi of male feebly dilated, the middle tarsi scarcely perceptibly so; tarsal formula in the female 4-4-4.

Length (not extended) about 2 mm.

Le Conte's type was taken by Melsheimer in York Co., Pennsylvania. It is a male and is the sole representative of the species in his collection. Horn states that the species occurs from Canada to Kentucky and from Pennsylvania to Missouri. There are before me specimens from Montreal, Can., Providence, R. I., and Cincinnati, Ohio.

Agathidium maculosum Brown.

Globose-oval, strongly convex; flavo- or rufotestaceous with black markings as follows:—a transverse occipital band; a median rounded pronotal spot of variable size; a sutural stripe which is dilated at base into a transverse quadriform area, a further lesser expansion at middle, behind which it is rapidly attenuate and does not reach the apex; also on each elytron two small discal longitudinal spots arranged transversely, the inner of which may or may not coalesce with the median expansion of the sutural stripe. Clypeal margin not advanced beyond the sides of the front, truncate, with very narrow membranous border; clypeal suture strongly impressed. Antennae with 3rd joint slender and elongate, 7th and 8th subequal. Hind angles of thorax rather sharply defined, subrectangular, their vertices narrowly rounded. Entire upper surface finely and sparsely punctate, the elytra a little less obscurely so; sutural stria wanting. Metasternum alutaceous, with a few fine punctures. The tarsal formula of the male is 5-5-4, and of the female 4-4-4. Length (contracted) about 2 mm.

This species was described by Mr. W. J. Brown (Can. Ent., 1928, p. 145) from five specimens including both sexes, all taken at Victoria, British Columbia, April 11, 1921 (W. Downes). Mr. Brown writes me "I find no trace of a fovea, but at the middle of

the metasternum is a transverse row of bristles. This row contains nine or ten bristles and its length is subequal to one-third the length of the metasternum on the median line." No mention is made in his description of any modification of the left mandible in the male and it is to be presumed none such is present.

In the material before me there are five examples of this species, three from Olympia, Washington, sent by Mr. Liebeck, and two females in my own collection, one from Goldstream, Vancouver Island (very near the type locality), the other from Madison, Washington. Two of Mr. Liebeck's specimens are males and in one of them I find the transverse row of bristles occupying a feebly eroded line on the metasternum, and in addition the left mandible is armed with a long slender curved horn. In the other male the horn is lacking. This is probably only another and very striking instance of that variability in the development of the mandibular horn which is referred to by Horn in his paper under *A. politum*, where he also alludes to a male of *A. pulchrum* in his collection in which the mandibles do not differ from those in the female.

In color and markings *maculosum* is strongly suggestive of *pulchrum*, but in the latter the pattern is a little different, and the unimpressed clypeal suture, broadly rounded hind angles of the thorax and presence of a sutural stria at once make the separation easy.

A. maculosum var. **franciscanum** var. nov.

Around San Francisco Bay there occurs a variety of this species which while perfectly in accord in all essential features, differs so constantly in one or two respects from the typical northern form as to merit a distinctive name.

In Brown's description of *maculosum* he says of the elytra—"disk without trace of striae," and this is substantially true of all the northern specimens seen. In them the elytral punctures are distributed without order over the whole surface though somewhat less distinct towards the sides. In *franciscanum* the elytral punctures are much fewer and still finer and nearly all contained in about four discal linear series, the inner one longest but reaching neither base nor apex, the elytra in more than outer half absolutely impunctate. Furthermore there is in *franciscanum* a narrow piceous stripe along the outer margin of the elytra, this not attaining the apex but continued along the oblique base above the humeral angle. In typical *maculosum* this dark marginal stripe is either entirely lacking or only vaguely indicated. The sexual characters are precisely as in the typical form, the mandibular horn, as in the latter, being sometimes present but more often wanting.

All specimens of this form that I have seen were submitted by Mr. Henry Dietrich, who took them at Berkeley and in Marin Co., California, January, 1920. They bore the name *A. pulchrum* and specimens may have been distributed as such by Mr. Dietrich. The type is a horned male from Berkeley and bears date Jan. 8, 1920.

Agathidium temporale n. sp.

Oval, a little elongate, moderately strongly convex; color throughout black or piceous, the antennae and legs only slightly less dark. Clypeus a little retracted and with a more or less obvious membranous border; clypeal suture not impressed. Head with distinct tempora, which however are rather short and of equal prominence with the eyes. Antennal stem dark rufous, the club piceous; 3rd joint gradually widened and distinctly longer than the 2nd but scarcely as long as the next two; stem bristling with numerous erect hairs. Upper surface moderately shining and exhibiting a relatively dense dual system of punctulation, consisting of fine punctures intermixed with still more minute ones, this sculpture being most evident on the elytra. Hind angles of thorax somewhat defined but with their vertices rounded. Elytra distinctly longer than wide; humeral angles well defined and obtuse; sutural stria reaching more than half way to base, moderately strongly impressed. Metasternum finely alutaceous and sparsely punctulate.

Length (not much extended) nearly 3 mm.

Described from a single male specimen taken at Randolph, New Hampshire (Sept.), by Mr. John D. Sherman, Jr., but now in the Blanchard collection at Cambridge, Mass. The type is a male with a long curved horn arising from the left mandible; there is an ante-median metasternal fovea from which rises a tuft of erect hairs, and the pro- and mesotarsi are distinctly dilated basally.

With the above type, which remains in the Blanchard collection, I have placed with some confidence an entirely rufotestaceous female which agrees in all essentials except that the punctuation is somewhat less dense and the minute punctules less evident. This specimen was collected by Mr. Blanchard himself at North Conway, New Hampshire, (June), and is in his collection.

This species by its distinct tempora and the character of the punctuation shows an unmistakable affinity with *angulare*, and with that alone, but differs therefrom in the modified left mandible of the male.

Agathidium assimile n. sp.

Oval, rather strongly convex, piceous black, above very strongly shining, surface polished; head and thorax sparsely very finely to almost impunctate, elytra less sparsely and quite strongly distinctly punctate. Antennae dark rufous, club piceous, stem bristling with erect hairs on the lower side; 3rd joint moderately elongate triangular, 7th not wider than the 8th. Clypeal margin a little retracted and with membranous border; clypeal suture not impressed. Head with evident post-ocular tempora. Elytra a little longer than wide, humeral angle fairly distinct but with rounded vertex, sutural stria moderate. Metasternum alutaceous, unusually densely and strongly punctate except for a small area each side along the rear margin.

In the male the left mandible is armed with a short acute triangular horn, the four anterior tarsi are moderately dilated, and there is a rounded setiferous ante-median metasternal fovea.

Length 2.25 to 2.5 mm.

Described from a male specimen taken at Indianapolis, Indiana, 7-14-10, with which I confidently associate a male and two females in the Blanchard collection, all bearing label "Mt. Washington, N. H., subalpine, 7-4-96." In these latter the pronotal punctures are a little more evident but variable among themselves, and the elytral punctures are somewhat less sparse. In the male the left mandible is armed with a long erect horn; the female tarsal formula is 5-4-4.

In its close and conspicuous metasternal punctuation this species alone closely parallels *alticola*, a species oddly enough also taken by Mr. Blanchard in the White Mountains on the same collecting trip, its label differing only in having a three days earlier date. Notwithstanding this coincidence and the further fact that the two species are identical in size, form and punctuation, *alticola* differs decisively by its entirely rufous antennae with nearly cylindrical third joint, the impressed clypeal suture, lack of tempora, and simple left mandible in the male.

Agathidium mollinum n. sp.

Broadly oval, strongly convex, black, highly polished; head and thorax nearly or quite impunctate, elytra very finely sparsely punctulate, the punctures in part subserially arranged. Legs and antennae brownish, the latter with the club somewhat darker. Head with distinct tempora; clypeal margin retracted and with narrow membranous border;

clypeal suture detectable but not impressed. Hind angles of thorax broadly rounded. Elytra slightly longer than wide; humeral angle well marked, a little obtuse; sutural stria moderate. Metasternum alutaceous and sparsely punctulate.

Length 1.75 mm. or slightly more.

Three examples of this rather small species are before me, all from the Blanchard collection. The type is a male labeled "White Mts., N. H., woods." In it the left mandible is a little stouter and somewhat prolonged but without horn. The other two examples are also males and were collected by Blanchard at "Rangeley Lake, Maine, Aug. '94." In neither of these is the left mandible either horned or distinctly prolonged, but in both the mandibles are more prominent than is usual in females, and in one of them the left mandible is a little larger than the right. Type in the Blanchard collection; paratype in my collection.

Agathidium pulchrum Lec.

This is one of the best known and most easily recognized species in our fauna. Only one other species—*maculosum* Brown—shares the distinction of possessing a variegated surface of yellowish or reddish and black markings, and these two species are instantly separable by the lack in *maculosum* and the presence in *pulchrum* of a sutural stria. The general character of the elytral markings is indicated in the tabular synopsis, but there is so much individual variation that hardly any two examples are completely identical in this respect.

The form is broadly oval, the surface shining and finely and sparsely but perceptibly punctulate. The antennae are dark rufous basally, joints 7–10 piceous, the terminal joint paler. Clypeus distinctly retracted with evident membranous border; clypeal suture not impressed. Hind angles of thorax rather broadly rounded. Metasternum alutaceous and sparsely punctulate. Tarsal formula of female 5-4-4.

Length 2 to 3 mm.

Localities represented in the material before me are: Alameda Co., Santa Cruz, Kaweah, Pasadena and Pomona, all in California; and a single example from the White Mountains, New Hampshire. Horn gives also Kentucky (Dury). My White Mts. example is a male with setiferous metasternal fovea; it is more minutely punctulate than the California specimens and the terminal joint of the antennal club is not paler, but seems not to differ otherwise. Horn

alludes to the variability in the structure of the left mandible of the male, and the fact that in one male before him the mandibles differ in no way from those of the female.

***Agathidium picipes* n. sp.**

Broadly oval, strongly convex, black or piceous, the antennae and legs concolorous except the tarsi, which are brownish. Clypeal margin a little retracted and with membranous border; clypeal suture not impressed. Upper surface polished, head and thorax minutely obsoletely punctulate, elytra sparsely and finely but more perceptibly so. Side margins of thorax nearly straight, the hind angles indicated and a little obtuse, their vertices rounded. Elytra nearly as wide as long; humeral angle a little obtuse, rather well defined; sutural stria moderate. Metasternum finely alutaceous at sides, smoother at middle, sparsely punctulate. In the male the left mandible is armed with a moderately long acute horn, and the metasternum bears an ante-median transverse scratch from which arises a row of fine erect hairs.

Length 1.75 to 2 mm.

Described from a single pair from California. The male type bears label Santa Cruz Co., VI; the female is from Santa Clara Co.

It is an almost invariable rule in this genus that in the dark colored species the antennae and legs are some shade of brown or reddish brown; the present species however is notable in having the the appendages black or nearly so.

***Agathidium difforme* Lec.**

Oval, a little more elongate than usual, strongly convex but only weakly contractile. Color an obscure brownish red, the pronotal disk, a scutellar or sutural triangle of variable extent, antennal club and metasternum, piceous. Upper surface strongly shining, the head finely but unusually distinctly punctate, thorax more finely and obscurely so, the elytra more strongly punctate and showing a more or less evident tendency toward a linear arrangement of the punctures, especially toward the suture. Clypeus truncate, with or without an evident membranous border; clypeal suture not impressed. Antennal stem rufous, the club piceous, 3rd joint elongate, 7th and 8th moderately transverse and subequal. Hind angles of thorax a little obtuse and rather sharply defined. Elytra perceptibly longer than wide, humeral angle distinct, a little obtuse; scutellar stria moderate. Mesosternum with an erect transverse laminiform process just before the middle coxae. Metasternum finely

alutaceous at sides, smooth at middle, sparsely punctate; in the male with a distinct transverse erosion bearing short erect hairs. Left mandible of male with a long curved horn. Tarsal formula of the male 5-5-4, of the female 5-4-4.

Length (body fully extended) about 2 mm.

Le Conte's type of this species is a male from Lake Superior. With it in his collection is a female from Detroit, Michigan. In addition to these specimens I have seen only two others, a male from Mt. Seward, 4500 ft., in the Adirondack Mts., in Mr. Liebeck's collection, and a female from the White Mts., New Hampshire, in the Blanchard collection. These all agree in the characteristic type of coloration but vary somewhat in the extent of the dark sutural triangle. The erect mesosternal lamina at the anterior limits of the mesocoxal process is in every way similar to the structure shown in *bistriatum* and *sexstriatum*, and in all three species the mesocoxal process is more nearly horizontal than usual.

There can be no doubt that the *A. canadensis* recently described by Mr. W. J. Brown (Can. Ent. 1930, p. 89) is identical with *difforme* Lec., of which it possesses every essential feature. The only apparent discrepancy is in respect to the membranous border of the clypeus. This is said to be present in *difforme* and absent in *canadensis*; I have shown however that this is an uncertain character, subject to much variation in this and other species.

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A CLASSIFICATION OF SOME NOCTUID LARVAE OF THE SUBFAMILY HYPENINAE

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In Barnes and McDunnough's Check List,¹ the nomenclature of which is followed in this paper, 44 genera and 178 species are included among the Hypeninae, of which 20 genera and 42 species are described as larvae in the following pages, together with an additional genus, *Litoprosopus* (?), which is included on the basis of one doubtfully determined specimen in the collection of the U. S. National Museum.

Barnes and McDunnough list a number of genera among the Hypeninae which were not previously associated with this subfamily, and several of these changes are supported by the available larval evidence, but the larva of *Spargaloma* would fit better in the Catocalinae-Erebinae, and examination of a single fragmentary larva of *Rivula propinqualis* Gn. indicates that, if this specimen is correctly determined, *Rivula* does not belong in the Hypeninae and probably would require a special subfamily.

In the preparation of this paper the author has become particularly indebted to Dr. Harold Morrison, who has granted facilities for studying the larval material in the collection of the National Museum, and to Carl Heinrich and F. H. Benjamin, for their uniform

¹ Barnes, Wm., and McDunnough, J. A. Check List of the Lepidoptera of Boreal America. Decatur, Ill. February, 1917.

kindly helpfulness on many occasions. In addition to the material studied in the National Museum, the writer has reared most of the species described, and grateful acknowledgment is due his old associates, J. U. Gilmore, K. B. McKinney, and Joe Milam, for their assistance in collecting larvae. The drawings in Plate XXIII were made by P. M. Eide, and the writer wishes to express his appreciation for this contribution.

The writer has seen larvae in somewhat less than half of the genera both in the Hypeninae and in the Catocalinae-Erebinae, in five of the eight genera in the Plusiinae, and in 98 of the 352 genera of the higher Noctuidae. To avoid constant reference to these limitations in the following discussion of larval relationships, the reader is requested to supply some expression such as "in so far as is known" in connection with general statements.

Two distinct types of larvae are found in the Hypeninae. What is referred to below as the herminoid type is peculiar to the Hypeninae and probably represents the closest approach in our fauna to the primitive Noctuid larva. The other, or hypenoid, type also includes the Catocalinae-Erebinae (except P^2 - P^2 in *Alabama* and head granules in some species of *Catocala* and *Melipotis*) and is not much different from the great mass of the Noctuidae. The distinguishing characteristics of these two types are as follows:

Larvae of the herminoid type.

P^2 - P^2 equal to but three-fourths of P^1 - P^1 .

P^1 usually nearer to L^1 than to median line of head and never more than slightly nearer to the median line.

With strong generic differences in the character and orientation of the tubercles and setae of body (Pl. XXIV, Figs. A-K).

Head granulose throughout.

Larvae of the hypenoid type.

P^2 - P^2 usually greater than P^1 - P^1 and never more than slightly less.

P^1 decidedly nearer to median line of head than to L^1 .

No marked generic differences in the character and orientation of the tubercles and setae of body (Pl. XXII, Figs. A-D).

Head smooth, or granulose on occiput only.

Spiracles not emarginate at ends.

The difficulties which usually beset any attempt to indicate the relationships of genera in a serial arrangement seem to be particularly pronounced in the Hypeninae, and the exact sequence in the

two major groups probably must remain largely a matter of opinion, especially in the herminoid section. The writer feels sure, however, that genera should be kept within the type group into which they fall.

Larvae of the hypenoid type seem to fall into reasonably well defined groups, but in the lower section of the herminoid larvae the segregation of genera into groups is a precarious procedure since, with the possible exception of *Phalaenostola-Philometra* and *Zanclognatha-Chytolita*, respectively, there is not a single instance of apparent relationship between two or more genera in which there are not incongruities which indicate that the genera must have had considerably different histories and that the apparent relationship may be entirely accidental. It seems desirable, however, that some record be made of the conclusions drawn from the larvae, and the writer ventures to offer the following outline.

As indicated above, the larvae of the Hypeninae of our fauna are separable into two distinct groups, but in the herminoid genera *Diallagma*, *Epizeuxis*, *Lascoria*, and *Tetanolita* spiracles of the hypenoid type are found, while in *Tetanolita* the arrangement of the head setae is of the hypenoid type. These similarities might be interpreted as indicating a tendency toward fusion of the two types, and it seems probable that they will be found to merge, but, in the present state of our knowledge, the data might be interpreted as indicating that the herminoids represent an ancient, conservative group distinct from the remainder of the Noctuidae. The hypenoid larvae included in this paper seem to divide into five groups. The herminoid larvae apparently divide to form two subtypes. Subtype A includes two otherwise unrelated genera, *Diallagma* and *Epizeuxis*. Subtype B is conceived as consisting of four branches. In the opinion of the writer the generic relationships are as follows:

Larvae of the hypenoid type

Bomolocha, *Platyhypena*, *Hypena*, *Saccharophagos*, *Scolecocampa*, *Litoprosopus* (?), and *Metalectra* have setigerous tubercles IV and V fused on the mesothorax and metathorax. This character is found in the Catocalinae-Erebinae in *Anomis* and *Alabama* alone and does not occur elsewhere in the Hypeninae except in *Epizeuxis*.

Bomolocha, *Platyhypena*, *Hypena*, and *Phiprosopus* have the hind coxae close together, while these coxae are very widely separated in *Saccharophagos*, *Scolecocampa*, *Litoprosopus* (?), and *Metalectra*. In the Catocalinae-Erebinae approximate hind coxae are usual among the lower genera, including *Anomis* and *Alabama*.

This condition does not occur elsewhere in the Hypheninae except in *Diallagma*.

Bomolocha, *Platyhyphen*a, and *Hyphen*a have a number of characters in common, as indicated in the key to genera, and are placed first. *Saccharophagos*, *Scolecocampa*, *Litoprosopus* (?), and *Metalectra* would follow in the order named. *Saccharophagos* and *Scolecocampa* have a number of characters in common, as indicated in the generic key; *Litoprosopus* (?) is very distinct, and *Metalectra* is a very peculiar genus with an arrangement of the setigerous tubercles on abdominal segment 1 not found elsewhere in the Hypheninae except in *Diallagma*.

Phiprosopus is an anomalous genus and the writer has no opinion to offer as to its position except that it belongs in this group.

Larvae of the herminoid type, except in Phalaenophana

Subtype A. Larvae with the prothoracic spiracle posterior in relation to the cervical shield and with non-emarginate spiracles.

Diallagma is placed first owing to the approximate hind coxae, which otherwise are found exclusively in the hypenoid larvae, and because of an arrangement of the ventral setae on abdominal segment 1 which occurs elsewhere in *Metalectra* alone. *Epizeuxis* would follow. Specific differences are unusually strong in this genus and it seems probable that *Epizeuxis* includes representatives of several ancient lines of development which happen to be similar in some respects.

Subtype B. Larvae with prothoracic spiracle anterior in relation to the cervical shield and usually with emarginate spiracles.

The tendency in this subtype appears to be toward a posteriorly tapered body form and the development of an anal fork and non-emarginate spiracles, and in each of the following groups the genera showing this tendency are placed first.

Phalaenophana is segregated owing to the hypenoid arrangement of the head setae. An anal fork is developed and the spiracles are emarginate in this genus. *Tetanolita*, *Renia*, and *Bleptina* share a number of characters, as indicated in the generic key. *Tetanolita* has an anal fork and very faintly emarginate spiracles and agrees with *Renia* in a number of characters, including peculiarities in the setigerous tubercles and their setae. *Renia* is peculiar in having the granules of the head arranged in a reticulate pattern, the interstices of which are in the form of pits. This condition is not found elsewhere in the Hypheninae except in *Bleptina*, where it occurs in a less pronounced form than in *Renia*. A third group would include

Lascoria and *Palthis*, which are peculiar in having a middorsal hump on abdominal segment 8. *Lascoria* has the spiracles non-emarginate and both genera have the body tapered posteriorly. A fourth group is conceived as including *Phalaenostola*, *Philometra*, *Hormisa*, and probably *Zanclognatha* and *Chytolita*. *Phalaenostola* and *Philometra* have an anal fork, and the character and orientation of the tubercles and setae are of a type not found elsewhere. These two genera and *Hormisa* have very peculiar spiracles, the outer margin being embedded in the skin. This is not found elsewhere except in *Diallagma*. The position of *Zanclognatha* and *Chytolita* is even more definitely uncertain than is usual in this subtype, but they have nearly flat tubercles as in *Hormisa* and a body outline not found elsewhere except in *Philometra*.

The following key is based on an examination of larvae in but 151 of the 469¹ genera of the Noctuidae, but this material has been well distributed through the family, except that no larvae have been seen in the Euteliinae and Hyblaeinae. It seems probable that the characters given will be sufficient for the proper placing of larvae in nearly all cases.

KEY FOR THE HYPENINAE

1. Setigerous tubercle VII^c absent on abdominal segment 1 (Pl. XXII, Fig. H) with rare exceptions in which either seta III on abdominal segment 9 is modified, threadlike, of a character different from setae I and II (Pl. XXI, Fig. I) and prolegs are present on abdominal segment 3 (*Perigea*, *Ogdoptera*) or setigerous tubercles I and II are approximate on a hump on anterior abdominal segments (*Harrisimemna*). Interspace P²-P² equal to or greater than P¹-P¹ or seta III modified on abdominal segment 9 2
- Setigerous tubercle VII^c present on abdominal segment 1 (Pl. XXII, Fig. I), except in *Palthis*, in which P²-P² is decidedly less than interspace P¹-P¹ and seta III is normal on abdominal segment 9 with both tubercle and seta normal, of the same character as tubercle and setae I and II (Pl. XXI, Fig. H), except in *Caenurgia*, *Pelamia*, and *Euclidia* in which prolegs are absent on abdominal segment 3. Setigerous tubercles I and II never approximate 3
2. Crochets on prolegs uniordinal (Pl. XXV, Fig. G) except in *Cucullia* Higher Noctuidae

¹ Following Dr. McDonnough's classification of the Agrotids (McDonnough, J. H. A Generic Revision of North American Agrotid Moths. Canada Dept. Mines, Natl. Museum of Canada, Bull. 55, 78 p., illus. 1928.)

Crochets on prolegs biordinal (Pl. XXV, Fig. I).

3. Crochets on prolegs biordinal Plusiinae in part
Crochets on prolegs uniordinal 4
4. Setigerous tubercle I minute (a mere setal insertion) on anterior abdominal segments or skin smooth, unless (*Melipotis*) setigerous tubercle VIII is spiracle-like, without a seta. No confluent setigerous tubercles in VII group on abdominal segments 1 and 2. Prolegs present on abdominal segment 4 unless the setigerous tubercles are minute. Setigerous tubercles I and II both minute on abdominal segment 8 or I decidedly smaller than II (Pl. XXIV, Fig. S), except in *Alabama*, in which setigerous tubercle III on abdominal segment 6 is in a transverse line with II and IV, and III^a is large and occupies the usual position of III (Pl. XXII, Fig. A). *Catocalinae-Erebinae*
- Setigerous tubercle I at least moderately large throughout. Skin granulose or hairy or with fused setigerous tubercles in VII group on abdominal segments 1 and 2, except in *Metalectra*, in which the prolegs are absent on abdominal segment 4. Setigerous tubercle VIII always bearing a seta. Setigerous tubercles I and II at least moderately large on abdominal segment 8 and I rarely much smaller than II. Setigerous tubercle III never in a transverse line with II and IV and III^a always very minute (Pl. XXII, Fig. C).
Hypeninae

KEY TO THE KNOWN GENERA OF LARVAE OF THE HYPENINAE

1. Head and body set closely with secondary hairs. Prominent fleshy middorsal processes on anterior abdominal segments. Ocelli I and II abruptly elevated above the surrounding surface of the head on a callus *Phiprosopus*
Head without secondary hairs. Body rarely with secondary hairs. No middorsal processes on anterior abdominal segments. Ocelli I and II usually with a small callus between them but never strongly elevated 2
2. Setigerous tubercle VI bearing four setae on prothorax and two each on mesothorax and metathorax *Litoprosopus* (?)
Setigerous tubercle VI bearing two setae on prothorax and one each on mesothorax and metathorax (Pl. XXI, Fig. A) 3
3. Interspace P²-P² never more than about two-thirds as great as P¹-P¹ (Pl. XX, Figs. D, F), except in *Phalaenophana*, in which the spiracles are emarginate at the ends (Pl. XXIII, Fig. G). Head granulose throughout 9
Interspace P²-P² equal to or greater than P¹-P¹ (Pl. XIX, Fig. A; Pl. XX, Fig. B). Head smooth or granulose on occiput

- only. Spiracles not emarginate at ends (Pl. XXIII, Fig. F) 4
4. Prolegs present on abdominal segment 4. Setigerous tubercle VII^b on abdominal segment I distinctly nearer to VII^c than to VIII (Pl. XXI, Figs. B, F). With fused setigerous tubercles in the VII group on abdominal segments 1 and 2 (Pl. XXII, Figs. B, D) 5
- Prolegs absent on abdominal segment 4. Setigerous tubercle VII^b on abdominal segment 1 approximately equidistant between VII^c and VIII (Pl. XXI, Fig. C). Without fused tubercles in the VII group *Metalectra*
5. Hind coxae very widely separated (Pl. XXV, Fig. B). Setigerous tubercles I^a and I^b not confluent on mesothorax and metathorax (Pl. XXII, Fig. F). Ocelli I and II without a callus between them. Three setigerous tubercles in the VII group confluent on abdominal segment 2 (Pl. XXII, Fig. D). Interspace VIII-VIII on abdominal segment 7 greater than VIII-VII. Setigerous tubercle A³ about twice as near to O² as to L¹ (Pl. XIX, Fig. B). Setigerous tubercle VII^b approximately twice as near to VII^a as to VII^c on abdominal segment I (Pl. XXI, Fig. B) 8
- Hind coxae not widely separated (Pl. XXV, Fig. E). Setigerous tubercles I^a and I^b confluent on mesothorax and metathorax (Pl. XXII, Fig. G). Ocelli I and II with a callus between them. But two confluent setigerous tubercles in the VII group on abdominal segment 2 (Pl. XXII, Fig. B). Interspace VIII-VIII on abdominal segment 7 less than VIII-VII. Setigerous tubercle A³ approximately equidistant between L¹ and O² or nearer to L¹ (Pl. XX, Fig. A). Setigerous tubercle VII^b on abdominal segment 1 approximately five times as near to VII^c as to VII^a (Pl. XXI, Fig. F) 6
6. Prolegs present on abdominal segment 3 *Bomolocha*
- Prolegs absent on abdominal segment 3 7
7. Interspace P¹-median line of head equal to two-thirds of P¹-L¹ (Pl. XX, Fig. B). Spinneret attenuate at tip (Pl. XXV, Fig. A). Head without dark markings *Platyhypena*
- Interspace P¹-median line equal to one-half of interspace P¹-L¹. Spinneret not attenuate at tip (Pl. XXV, Fig. C). Head with dark markings dorsally *Hypena*
8. Setigerous tubercles I and II distinctly separate on abdominal segment 9. Setigerous tubercle III not directly anterior to the spiracle on abdominal segment 8 *Saccharophagos*
- Setigerous tubercles I and II with their bases fused on abdominal segment 9. Setigerous tubercle III directly anterior to the spiracle on abdominal segment 8. *Scolecocampa*

9. Prolegs absent on abdominal segment 4. Setigerous tubercle VII^b on abdominal segment 1 decidedly nearer to VIII than to VII^c (Pl. XXI, Fig. D). Hind coxae touching.

Diallagma

Prolegs present on abdominal segment 4. Setigerous tubercle VII^b on abdominal segment 1 decidedly nearer to VII^c than to VIII (Pl. XXI, Fig. E). Hind coxae never touching.....10

10. Prothoracic spiracle on the line of the posterior margin of the cervical shield (Pl. XXIII, Fig. E). Spiracles not emarginate at ends (Pl. XXIII, Fig. F; Pl. XXIV, Fig. N). Ocellus I flat on the head, not borne on a callus.....*Epizeuxis*

Prothoracic spiracle anterior to the posterior margin of the cervical shield (Pl. XXIII, Figs. A-D). Spiracles distinctly emarginate at ends except in *Lascoria* and *Tetanolita* (Pl. XXIII, Fig. G; Pl. XXIV, Fig. M). Ocellus I inclined posteriorly, on a small callus 11

11. Setigerous tubercles P¹-P¹ with their interspaces less than P²-P². Setigerous tubercle P¹ decidedly nearer to the median line of the head than to L¹. Subanal setae very close together, developed as an anal fork (Pl. XXIII, Fig. H).

Phalaenophana

Setigerous tubercles P¹-P¹ with their interspace decidedly greater than P²-P² (Pl. XX, Figs. D, F). Setigerous tubercle P¹ but little if any nearer to the median line than to L¹. Subanal setae usually well separated, rarely developed as an anal fork (Pl. XXIII, Fig. I) 12

12. With a distinct middorsal hump on abdominal segment 8. Body tapering posteriorly 13

Without a middorsal hump on abdominal segment 8. Body usually broad posteriorly 14

13. Hump on the dorsum of abdominal segment 8 including setigerous tubercle I. Setigerous tubercle II on abdominal segment 8 but slightly larger than elsewhere. Granules of skin in the form of short, stout spines (Pl. XXV, Fig. J). Setigerous tubercle VII^c about twice as near to VII^b as to VIII on abdominal segment 2 and absent on abdominal segment 1. Spiracles emarginate at ends (Pl. XXIV, Fig. M, d).

Palthis

Hump on dorsum of abdominal segment 8 including setigerous tubercle II, which is much larger on 8 than on the preceding segments. Skin with minute rounded granules. Setigerous tubercle VII^c nearly equidistant between VII^b and VIII on abdominal segment 2 and present on segment 1. Spiracles not emarginate at ends, extremely narrow, twice as high as wide*Lascoria*

14. Setigerous tubercles $A^1-A^2-A^3$ forming a very obtuse angle at A^2 (Pl. XX, Fig. F). Setigerous tubercle IV on abdominal segment 5 at least about one-fourth nearer to III than to V, measured between the setal insertions. Setigerous tubercle IV on abdominal segment 4 usually less than the width of the spiracle removed therefrom. Dorsal setae of body usually blunt or enlarged at tip (Pl. XXIV, Figs. E, H, I) 19
- Setigerous tubercles $A^1-A^2-A^3$ forming approximately a right angle at A^2 . Setigerous tubercle IV on abdominal segment 5 equidistant between III and V or near to V, measured between the setal insertions. Setigerous tubercle IV on abdominal segment 4 distinctly more than the width of the spiracle removed therefrom. Setae of body pointed at tip (Pl. XXIV, Figs. A-C, G, J) 15
15. Subanal setae close together, developed as an anal fork (Pl. XXIII, Fig. H). Anal shield strongly declivous posterior to the antero-dorsal setigerous tubercles. Setigerous tubercles I and II directed posteriorly, their setae stout, bluntly pointed, about twice as long as the width of their tubercles (Pl. XXIV, Figs. A, B). Spiracles peculiar, the outer margin embedded in the skin and indistinct 16
- Subanal setae well separated, not developed as an anal fork (Pl. XXIII, Fig. I). Anal shield not strongly declivous posterior to the antero-dorsal setigerous tubercles. Setigerous tubercles I and II not directed posteriorly except slightly on abdominal segments 7 and 8, their setae slender or very short (Pl. XXIV, Figs. C, G, J) 17
16. Abdominal segments of about equal width throughout, with 7 and 8 slightly broadened. Setae I and II directed strongly posteriorly, almost parallel with the dorsum (Pl. XXIV, Fig. B) *Philometra*
- Body tapering posteriorly. Setae I and II directed somewhat posteriorly but far from parallel with the dorsum (Pl. XXIV, Fig. A) *Phalaenostola*
17. Body tapering posteriorly. Anal shield elongate, the posterior setigerous tubercles very strongly produced. Dorsal setae nearly twice as long as the width of their tubercles (Pl. XXIV, Fig. C). Spiracles peculiar, the outer margin embedded in the skin and indistinct. Interspace VII^b-VII^c on abdominal segment 1 nearly equal to VII^b-VIII (Pl. XXI, Fig. G) *Hormisa*
- Body broadened posteriorly. Anal shield rounded, the posterior setigerous tubercles not very strongly produced. Dorsal setae no longer than the width of their tubercles (Pl. XXIV, Figs. G, J). Spiracles normal, the outer margin sharply defined. Interspace VII^b-VII^c on abdominal segment 1 decidedly less than VII^b-VIII (Pl. XXI, Fig. E) 18

18. Spinneret shorter and stouter (Pl. XXV, Fig. F).
Zanclognatha
 Spinneret longer and more slender (Pl. XXV, Fig. D).
Chytolita
19. Anterior abdominal spiracles large, twice as high as wide (Pl. XXIV, Figs. M, b). Insertion of seta IV on prothorax below the line of the center of the spiracle (Pl. XXIII, Fig. C). Dorsal setigerous tubercles nearly flat, their setae very strongly clavate or balloon-shaped, II no longer than the width of its tubercle (Pl. XXIV, Fig. I) *Bleptina*
 Anterior abdominal spiracles small, less than twice as high as wide (Pl. XXIV, Figs. M, a). Insertion of seta IV on prothorax above the line of the center of the spiracle (Pl. XXIII, Figs. B, D). Dorsal setigerous tubercles distinctly elevated, their setae rarely more than slightly enlarged at tip, if at all, II usually twice as long as the width of its tubercle (Pl. XXIV, Figs. E, H) 20
20. Prespiracular shield elongate, wedge-shaped, very narrowly separated from or connate with the cervical shield (Pl. XXIII, Figs. B, D). Spiracles strongly emarginate at the ends (Pl. XXIV, Fig. M, a). Head without pigment reticulation, the granules arranged in a reticulate pattern dorsally enclosing pits *Renia*
 Prespiracular shield rounded, well separated from the cervical shield. Spiracles but very slightly emarginate at ends. Head with pigment reticulation, the granules not arranged in a reticulate pattern and not enclosing pits *Tetanolita*

Bomolocha Hübner

Body broadest through anterior abdominal segments and tapering strongly posteriorly. Skin smooth or with very minute granules. Hind coxae very close together. Prolegs present on abdominal segment 3. Anal shield normal. Prothoracic spiracle on the line of the posterior margin of the cervical shield. Prespiracular shield well rounded, separated from the cervical shield. Spiracles neither elevated nor emarginate at ends. Head and body without reticulation.

Setigerous tubercles rather large and distinctly elevated. Setae about half the length of an abdominal segment, pointed at tip.

IV on prothorax above the center of spiracle.

Interspace VIII-VIII on abdominal segment 7 less than VIII-VII.

VII on abdominal segment 7 nearer to VI than to VIII.

VII^a remote from VII^b and VII^c on abdominal segment I.

I^a and I^b confluent on mesothorax and metathorax.

IV and V confluent on mesothorax and metathorax.

VII^b and VII^c confluent on abdominal segment 1.

Subanal setae not modified as an anal fork.

Head smooth, ocelli I and II with a callus between them. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ less than P²-P².

Λ¹-Λ²-Λ³ forming a very obtuse angle at Λ².

Λ³ approximately equidistant from O² and L¹.

P¹ about twice as near to the median line as to L¹.

Although this genus includes sixteen species, the writer has examined larvae in but three, and but one larva has been seen in each of these species.

KEY TO LARVAE OF THE SPECIES

Setigerous tubercles of body green *palparia* Walker
Setigerous tubercles of body pink *caducalis* Walker

Bomolocha palparia Walker (*scutellaris* Grote)

Head 2 mm. broad. Body about 17 mm. long and 3 mm. broad at middle. Green throughout, apparently without markings, but this is uncertain since the larva is decolorized preparatory to pupation. Setigerous tubercles of body green, their setae nearly or quite black. Spiracles yellowish with brown rims. Head green, setigerous tubercles Λ³, P¹, P², and L¹ black.

Described from one live larva collected July 4, 1925, at Clarksville, Tenn. Moth determined by F. H. Benjamin.

Food plant: Larva taken on trunk of oak.

Distribution: New York, Connecticut, Pennsylvania, and Maryland, southward to Tennessee; also reported from British Columbia.

Bomolocha caducalis Walker.

Head 2.5 mm. broad. Body about 20 mm. long and 3 mm. broad at middle. Green throughout with a broken pale line ventrad of setigerous tubercle II. Setigerous tubercles of body pink. Spiracles pale with brown rims. Head with a dark spot anterior to setigerous tubercle P¹.

Described from one inflated larva in the National Museum collection labelled "On walnut, September 3, 1882. No. 2841."

Food Plant: Walnut.

Distribution: New York to Delaware and westward to North Dakota, Missouri, and Texas.

Platyhypena Grote

Body broadened through anterior abdominal segments, and tapering decidedly posteriorly. Skin with extremely minute

rounded granules. Hind coxae very close together. Prolegs absent on abdominal segment 3. Anal shield normal. Prothoracic spiracle on the line of the posterior margin of the cervical shield. Prespiracular shield remote from cervical shield. Spiracles neither elevated nor emarginate at ends.

Setigerous tubercles rather large, conical. Setae rather stout, pointed at tip, about one-third as long as an abdominal segment.

IV on prothorax above center of spiracle.

Interspace VIII-VIII on abdominal segment 7 less than VIII-VII.

VII on abdominal segment 7 nearer to VI than to VIII.

VII^a remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b confluent on mesothorax and metathorax.

IV and V confluent on mesothorax and metathorax.

VII^b and VII^c confluent on abdominal segment 1.

Subanal setae not modified as an anal fork.

Head smooth, ocelli I and II with a callus between them.

Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ less than P²-P².

A¹-A²-A³ forming a very obtuse angle at A².

A³ slightly nearer to L¹ than to O².

F¹ distinctly nearer to margin of front than to F^a.

P¹ to the median line equal to two-thirds P¹ to L¹.

But one species is included in this genus.

Platyhypena scabra Fabricius

Pl. XX, Figs. A, B; Pl. XXII, Fig. G; Pl. XXV, Figs. A, E.

Head 2 mm. broad. Body about 25 mm. long and 2.5 mm. broad at middle. General color green with white lines.

Body green both dorsally and ventrally. A geminate mid-dorsal line, a broken line somewhat ventrad of setigerous tubercle II, and a narrow band including the spiracles, white. No white subspiracular stripe. Spiracles white with brownish rims. Setigerous tubercles green, the setal insertions and setae brownish. Head smooth, green, without markings.

Described from many live larvae collected August 20, 1926, at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food Plants: Alfalfa, clover, beans, strawberry, *Ambrosia trifida*.

Distribution: Nova Scotia, New York, Pennsylvania, and North Carolina westward to Minnesota, Kansas, and Texas.

Hypena Schrank

Body broadest through the anterior abdominal segments and tapering decidedly posteriorly. Skin either smooth or with

very minute granules. Hind coxae very close together. Prolegs absent on abdominal segment 3, present on abdominal segment 4. Anal shield normal. Prothoracic spiracles on the line of the posterior margin of the cervical shield. Prespiracular shield rounded, remote from the cervical shield. Spiracles neither elevated nor emarginate at ends.

Setigerous tubercles rather large, somewhat conical. Setae rather stout, pointed at tip, about one-third the length of an abdominal segment.

IV on prothorax above the center of the spiracle.

Interspace VIII-VIII on abdominal segment 7 less than VIII-VII.

VII on abdominal segment 1 variable in relation to VI and VIII.

VII^a remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b confluent on mesothorax and metathorax.

IV and V confluent on mesothorax and metathorax.

VII^b and VII^c confluent on abdominal segment 1.

Subanal setae not modified as an anal fork.

Head smooth, or obscurely granulose dorsally, ocelli I and II with a callus between them, without pigment reticulation, but flecked with blackish dorsally. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ less than P²-P².

A¹-A²-A³ forming a very obtuse angle at A².

A³ slightly nearer to L¹ than to O².

F¹ distinctly nearer to the lateral margin of the front than to F^a.

P¹ approximately twice as near to the median line as to L¹.

Four species are credited to this genus, all of which are here described in the larval stage.

KEY TO LARVAE OF THE SPECIES

1. Ground color of head green. Dorsum of body green 2
Ground color of head white. Dorsum dusky owing to the presence of close-set, very minute, rounded, blackish granules. *decorata* Smith
2. Skin smooth, entirely without granules *californica* Behr
Skin set closely with minute granules 3
3. Granules of skin pointed, upright, spine-like *humuli* Harris
Granules of skin very minute, rounded, not upright. *modesta* Smith

Hypena humuli Harris

Head 1.8 mm. broad. Body about 18 mm. long and 3 mm. broad at middle. General color green with white lines.

Dorsum green, venter lighter green. A geminate middorsal line and a line ventrad of setigerous tubercle II, white. White stripe including the spiracles apparently absent. Spiracles pale yellowish or white with brownish rims. Setigerous tubercles dark, including those on the head. Head green freckled with dilute black dorsally, coarsely, obscurely granulose dorsally.

Described from four alcoholic larvae in the National Museum collection labelled "Richfield Springs, N. Y., June 1887."

Food Plants: Hop (*Humulus lupulus* L.) and stinging nettle (*Urtica* spp.).

Distribution: Washington, Montana, and New York southward to Utah, Colorado, Kansas, and Virginia; also reported from Alabama.

Hypena californica Behr

Pl. XXII, Fig. B; Pl. XXV, Fig. H.

Head 1.8 mm. broad. Body about 21 mm. long and 2 mm. broad at middle. General color green with white lines.

Body green both dorsally and ventrally, faintly suffused with pinkish. A deeper green subcutaneous middorsal line. A strong white line just ventrad of setigerous tubercle II and traces of a pale subspiracular line. Spiracles white with blackish rims. Setigerous tubercles of body green with dark setal insertions. Head green freckled with black on posterior half, the setigerous tubercles black.

Described from many live larvae collected in May, June, July, and August at Puyallup, Wash. Moths determined by William Schaus.

Food Plant: Stinging nettle (*Urtica lyalli* S. Wats.).

Distribution: California to Washington and British Columbia.

Hypena modesta Smith

Head 1.7 mm. broad. Body about 22 mm. long and 2 mm. broad at middle. General color green, apparently without white lines.

Setigerous tubercles green with dark setal insertions. Spiracles pale with brown rims. Head green, the setigerous tubercles dark.

Described from one inflated larva in the National Museum collection labelled "Nevada County, California. On nettle. No. 197."

Food Plant: Stinging nettle (*Urtica* sp.).

Distribution: California.

Hypena decorata Smith

Pl. XXI, Fig. F; Pl. XXV, Fig. C.

Head 2 mm. broad. Body about 25 mm. long and 3 mm. broad at middle. General color dark dorsally.

Dorsum to ventrad of setigerous tubercle II dusky, with a dark middorsal stripe, tubercles I and II in pale spots. A strong dark stripe dorsad of setigerous tubercle III, remainder of supraspiracular area paler than the dorsum. Yellowish band below and partially including the spiracles, more evident ventrally. Venter unmarked, tinged with pinkish. Spiracles yellowish with black rims. Setigerous tubercles pale or green with rather large dark setal insertions, III tending to be wholly black. Head white densely freckled with black, the freckles sometimes fused posteriorly, setigerous tubercles black.

Described from many larvae collected during June and July at Puyallup, Wash. Moths determined by Carl Heinrich.

Food Plant: Stinging nettle (*Urtica lyalli* S. Wats.).

Distribution: Washington to California.

Saccharophagus Schaus (*Gabara* Walker in part)

Abdominal segments of about equal width throughout. Skin set closely with small, rounded granules. Hind coxae widely separated. Prolegs absent on abdominal segment 3. Anal shield normal, the dorsal setae posterior. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Prespiracular shield irregular in outline, but little removed from the margin of the cervical shield. Head and body without pigment reticulation.

Setigerous tubercles of body large, rather flat; their setae stout, pointed at tip, very long.

IV on prothorax below center of spiracle.

Interspace VIII-VIII on abdominal segment 7 greater than VIII-VII.

VII on abdominal segment 7 nearer to VIII than to VI.

Interspace VII^b-VII^a on abdominal segment 1 distinctly less than VII^b-VII^c; the two equal on segment 2.

I^a and I^b not confluent on mesothorax and metathorax.

IV and V confluent on mesothorax and metathorax.

VI approximately equidistant from VII^a and V on abdominal segment 1.

VII^a and VII^b confluent on abdominal segment 1.

Subanal setae not developed as an anal fork.

Head brown, freckled with small, dark spots, scarcely granulose. Front narrowed strongly at base. Ocelli I and II without

a callus between them. Arrangement of setigerous tubercles as follows:

Interspace P^1-P^1 very slightly greater than P^2-P^2 .

$A^1-A^2-A^3$ forming approximately a right angle at A^2 .

A^3 twice as near to O^2 as to L^1 .

F^1 much nearer to the lateral margin of front than to F^a .

P^1 about three times as near to the median line as to L^1 .

Three or four species probably are included in this genus.

Saccharophagos mochisa Schaus

Head 3 mm. broad. Body about 30 mm. long and 5 mm. broad, abdominal segments of about equal width throughout. General color pale, without markings, with large brown or black setigerous tubercles. Spiracles black throughout. Head brown, flecked with small dark spots.

Described from two alcoholic larvae in the collection of the U. S. National Museum labelled "In cane, February 1923. Los Mochis, Sinaloa, Mexico, R. H. Van Zwaluwenburg coll."

Food: Van Zwaluwenburg¹ states that this larva often gnaws a rough cavity at the base of stalks of sugar cane and is sometimes found feeding on trash about the sprouted eyes several feet above ground.

Distribution. Mexico.

Scolecocampa Guenée

Abdominal segments of equal width throughout. Skin with very small, rounded granules, particularly near the margins of the segments. Hind coxae very widely separated. Prolegs absent on abdominal segment 3. Anal shield normal, rather coarsely granulose. Prothoracic spiracle decidedly anterior to the line of the posterior margin of the cervical shield. Pre-spiracular shield rather narrowly separated from the cervical shield. Spiracles neither elevated nor emarginate at ends. Head and body without markings.

Setigerous tubercles large, somewhat elevated. Dorsal setae stout, pointed at tip, more than half as long as an abdominal segment.

IV on prothorax above center of spiracle.

Interspace VIII-VIII on abdominal segment 7 distinctly greater than VIII-VII.

VII on abdominal segment 7 nearer to VI than to VIII.

¹ Van Zwaluwenburg, R. H. Insect Enemies of Sugarcane in Western Mexico. Jour. Econ. Ent., vol. 19, p. 668, August 1926.

III directly anterior to spiracle on abdominal segment 8.

I and II with bases confluent on abdominal segment 9.

I^a and I^b separate on mesothorax and metathorax.

IV and V confluent on mesothorax and metathorax.

Two confluent tubercles in VII group (VII^a and VII^b) on abdominal segment 1.

Subanal setae not modified as an anal fork.

Head with impressed lines, and obscurely granulose dorsally.

Ocelli I and II without a callus between them.

Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ a little less than P²-P².

A¹-A²-A³ forming a rather obtuse angle at A².

A³ nearly twice as near to O² as to L¹.

F¹ much nearer to the margin of front than to F^a.

P¹ about twice as near to the median line as to L¹.

This genus includes two species.

Scolecocampa liburna Geyer

Pl. XIX, Figs. A, B; Pl. XXI, Fig. B; Pl. XXII, Figs. C, D.

Head 3.1 mm. broad. Body about 35 mm. long and 4 mm. broad at middle. Skin with obscure, small, rounded granules, transparent. General color whitish, without markings.

Cervical shield dark fuscous, transversely oblong, extending laterally almost to the spiracle. Anal shield dark fuscous, large, semicircular in outline. Legs fuscous. Crochets of prolegs very long and slender. Spiracles small, dark fuscous. Setigerous tubercles large, dark fuscous, shining.

Head deep uniform black, with obscure coarse granules dorsally.

The larvae live in tunnels in rotten wood, the mouths of which are sometimes closed by a mass of frass and silk. They are found in wood so far gone in decay that larvae and adults of *Passalus cornutus*, angleworms, and millipedes are the chief forms of life with which the larvae are associated.

Described from twenty live larvae collected September 14, 1920, at Magnolia, Tenn. Moths determined by H. G. Dyar.

Food: Decayed logs and stumps of oak, sycamore, and other trees.

Distribution: New York, North Carolina, and Florida westward to Missouri and Texas.

Litoprosopus Grote (?)

Body of about equal width from the mesothorax to abdominal segment 8. Skin with small, isolated, spine-like granules.

Hind coxae extremely far apart. Prolegs present on abdominal segment 3. Anal shield normal. Prespiracular shield well separated from cervical shield. Spiracles neither elevated nor emarginate at ends. Setigerous tubercles large, II and III in particular, strongly conical, II about four times as large as I, III at least five times as large as IV, I and II very unusually close together, not more than the width of I removed from each other. Setae extremely long, longer than an abdominal segment, pointed at tip.

IV on prothorax below center of spiracle.

Interspace VIII-VIII on abdominal segment 7 much greater than VIII-VII.

I^a and I^b confluent on mesothorax and metathorax.

Two confluent setigerous tubercles (VII^b and VII^c) on abdominal segment 1.

Subanal setae not modified as an anal fork.

VI with four setae on prothorax, two each on mesothorax and metathorax.

VII^c four times nearer to VII^b than to VIII.

Head strongly, transversely rugulose, not granulose. Ocelli I and II not on a callus. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ slightly less than P²-P².

A¹-A²-A³ forming a slightly acute angle at A².

A³ nearer to L¹ than to O².

Two species are included in *Litoprosopus*.

Litoprosopus futilis Grote & Robinson (?)

Head 4.2 mm. broad. Body about 38 mm. long and 6 mm. broad at middle. General dorsal color apparently reddish brown.

A geminate pale middorsal line including and bordered broadly by reddish brown and with transverse white lines and spots between setigerous tubercles I and II. Traces of broad, broken, pale longitudinal lines between I and II, and ventrad of II. A broad pale band with the spiracles well within it. The reddish brown dorsal coloration encroaches upon this pale band posterior to the spiracles, where but a narrow margin of white remains.

Supraspiracular area reddish brown reticulate with white. Spiracles entirely black. Venter of dorsal color becoming more dilute midventrally. Cervical shield large, brown, polished, the setigerous tubercles not elevated.

Setigerous tubercles dark, II and III in particular being strongly conical, II about four times as large as I, III at least five times as large as IV, I and II very unusually close together,

being not more than the width of I apart. Setae black, pointed at tip and extremely long, the seta on 3 being decidedly longer than an abdominal segment.

Head uniform brown or black except for an oblique pale line posterior to ocellus I, strongly transversely rugulose but not granulose. Ocelli I and II are peculiar in that their interspace is greater than that of ocelli II and III.

- Described from one inflated larva in the U. S. National Museum collection labelled "Astoria, Florida, saw palmetto, No. 9261, H. G. Dyar collector." Doctor Dyar was not certain that this larva was *futilis* but stated that *futilis* fed upon saw palmetto.

This larva is peculiar in several respects, particularly in the character of setigerous tubercle VI on the thorax, but otherwise seems to fit in very well near the head of the series of hypenoid genera.

Distribution: Georgia and Florida.

Phiprosopus Grote

Body broadest through anterior abdominal segments, a mid-dorsal hump on abdominal segment 1, a middorsal, tapered, fleshy process on segment 2, longer than the segment, a shorter middorsal process on segment 3, a decided middorsal hump on segment 8, and distinct latero-ventral lobes on segments 8 and 9. Head and body bearing numerous secondary hairs. Hind coxae contiguous. Prolegs absent on abdominal segments 3 and 4. Anal shield normal, thin. Prothoracic spiracle on the line of the posterior margin of the cervical shield. Prespiracular shield remote from the margin of the cervical shield. Head and body without pigment reticulation.

Setigerous tubercles of body small, merely a minute chitinous ring at the setal insertion; their setae moderately long, slender, pointed at tip.

IV on prothorax above center of spiracle.

Interspace VIII-VIII apparently many times as great as VIII-VII on abdominal segment 7.

V and VI apparently close together on a fleshy prominence on abdominal segment 7.

Interspace VII^a-VII^b twice as great as VII^b-VII^c on abdominal segment 1; relationship similar on abdominal segment 2.

I^a and I^b not confluent on mesothorax and metathorax.

IV and V not confluent on mesothorax and metathorax.

No confluent setigerous tubercles in VII group on abdominal segment 1.

Subanal setae not developed as an anal fork.

Head brown, with numerous secondary hairs, smooth. Ocelli

I and II abruptly elevated above the surrounding surface of the head on a callus. Arrangement of setigerous tubercles as follows:

Interspace P^1 – P^1 greater than P^2 – P^2 .

A^3 more than twice as near to O^2 as to L^1 .

F^1 distinctly nearer to margin of front than to F^a .

P^1 decidedly nearer to median line of head than to L^1 .

Two species are included in this genus.

Phiprosopus callitrichoides Grote

Head 2.5 mm. broad. Body about 25 mm. long and 3.5 mm. broad at middle. General color brown with a conspicuous pale or pinkish lateral stripe strongly produced ventrally on abdominal segments 4, 5, and 6, extending as a narrow stripe between setigerous tubercle III and the spiracle on abdominal segment 7, and continuing dorso-posteriorly upon segment 8, where it seems to occupy most of the area included by setigerous tubercles I, II, and III. Head with secondary hairs, smooth, brown, with the adfrontal areas and a narrow stripe mediad of the ocelli, pale. The specimen is not in good condition for description.

Described from one alcoholic larva in the collection of the U. S. National Museum labelled "New Haven, Conn., Nov. 1901. A. H. Verrill coll."

Food: Green briar (*Smilax rotundifolia* L.).

Distribution: New York, District of Columbia, North Carolina, Alabama, and Texas.

*Metalectra*¹ Hübner

Abdominal segments broadened somewhat posteriorly. Skin minutely granulose, sometimes appearing smooth. Hind coxae widely separated. Prolegs absent on abdominal segment 3 and 4. Anal shield produced and upturned on posterior margin (at least in *quadrisignata*). Prothoracic spiracle on the line of the posterior margin of cervical shield. Prespiracular shield rounded, remote from cervical shield. Spiracles broad, neither elevated nor emarginate at ends. Head with distinct pigment reticulation. Body scarcely reticulate.

Setigerous tubercles of body broadly bell-shaped, moderately large, and distinctly elevated. Setae rather stout, half as long as an abdominal segment, pointed at tip, I directed anteriorly and II posteriorly on the abdomen.

¹ This is the original spelling.

IV on prothorax above center of spiracle.

Interspace VIII-VIII on abdominal segment 7 less than VIII-VII.

VII on abdominal segment 7 nearer to VI than to VIII.

VII^a remote from VII^b and VII^c on abdominal segment 1.

VII^c anterior to VII^a.

I^a and I^b may or may not be confluent on mesothorax and metathorax.

IV and V confluent on mesothorax and metathorax.

No confluent tubercles in VII group.

Subanal setae not modified as an anal fork.

Head either smooth or granulose, ocelli I and II without a callus between them. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ less than P²-P².

A¹-A²-A³ forming approximately a right angle at A².

A³ approximately equidistant from O² and L¹.

F¹ nearer to margin of front than to F^a.

P¹ three times as near to median line as to L¹.

Seven species are credited to this genus, and of these but two species have been described in the larval stage.

KEY TO THE KNOWN LARVAE OF THE SPECIES

Setigerous tubercles I^a and I^b confluent on mesothorax and metathorax (Pl. XXII, Fig. G). Head set sparingly with subconical granules on occiput *tantillus* Grote

Setigerous tubercles I^a and I^b separate on mesothorax and metathorax (Pl. XXII, Fig. F). Head entirely smooth.
quadrisignata Walker

Metalectra tantillus Grote (*monodia* Dyar)

Head 1.4 mm. broad. Body about 19 mm. long and 3 mm. broad at middle. General color brown, made up of flecks of infuscated brown and reddish.

With a geminate pale middorsal line including dark fuscous spots anterior to setigerous tubercles I, between I and II, and posterior to II. Similar spots ventrad of I and II. Coloration paler midventrally. Spiracles pale or brownish with dark rims. Setigerous tubercles conspicuously prominent even on the venter, I reddish brown, II pale. Head closely reticulate with dark brown, without definite submedian arcs, set sparsely with subconical granules.

Described from one inflated larva in the United States National Museum collection, labelled "Under a log. July 22."

Food: Probably fungus.

Distribution: North Carolina, Georgia, and Florida.

Metalectra quadrisignata Walker (*tactus* Grote)

Pl. XXI, Fig. C.

Head 1.6 mm. broad. Body about 18 mm. long and 3 mm. broad at middle. General color indeterminable.

Body marked with blackish, which is especially conspicuous on the anterior portion of the segments between setigerous tubercles I and III. Setigerous tubercles but moderately prominent, I and II apparently of the same color.

Ground color of head apparently white overlaid by fuscous reticulation. Spiracles pale or brownish with black rims. The crochets on the prolegs are very long and slender, which also is true in *M. tantillus*.

Described from one mature and two immature larvae collected September 17, 1928, at Concordville, Pa., by C. A. Thomas. Moths determined by Frank Haimbach.

Food: Cultivated mushrooms.

Distribution: Pennsylvania, North Carolina, Georgia, and Florida.

Diallagma Smith

Body decidedly broadened through the metathorax and first abdominal segment and tapering to the rather blunt posterior extremity. Skin, including the setigerous tubercles, set with rather small, somewhat isolated, rounded granules. Hind coxae very close together. Prolegs absent on abdominal segments 3 and 4. Anal shield with median posterior setae distinctly lower than adjacent setae. Prothoracic spiracle on the line of the posterior margin of the cervical shield. Prespiracular shield rounded, remote from the cervical shield. Spiracles neither elevated nor emarginate at ends, retracted into the skin on the anterior abdominal segments. Head with pigment reticulation. Body not reticulate.

Setigerous tubercles rather large, and distinctly elevated, subcylindrical on abdominal segments posterior to 3, on which segments tubercle II is distinctly larger than I, II prostrate on abdominal segments 8 and 9. Setae blunt, tending to arise from the posterior face of their tubercles, except II on abdominal segment 8, and no longer than the width of their tubercles, I and II both directed posteriorly, except on abdominal segment 8.

IV on prothorax far below center of spiracle.

Interspace VIII-VIII on abdominal segment 7 slightly less than VIII-VII.

VII on abdominal segment 7 slightly nearer to VI than to VIII.

VII^a remote from VII^b and VII^c on abdominal segment 1.

VII^b slightly anterior to line VI to VIII on abdominal segment 1.

I^a and I^b well separated on mesothorax and metathorax.

IV and V separated on mesothorax and metathorax.

No confluent tubercles in VII group.

Subanal setae probably modified as an anal fork.

Head with rather small rounded granules. Ocelli I and II without a callus between them. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ greater than P²-P².

A¹-A²-A³ forming a very obtuse angle at A².

A³ approximately equidistant from O² and L¹.

F¹ distinctly nearer to F^a than to the margin of front.

P¹ approximately equidistant between the median line and L¹.

Two species are included in this genus.

Diallagma latiorella Walker

Pl. XXI, Fig. D; Pl. XXIV, Fig. K.

Head 1.4 mm. broad. Body about 16 mm. long and 2 mm. broad at middle. General color rather dark.

Dorsum to just ventrad of setigerous tubercle II dark tinged with reddish and bordered laterally by a pale line; a narrow dark middorsal stripe. From ventrad of setigerous tubercle II to and including the spiracles abruptly much paler, flecked and streaked with reddish brown and darker in the line of the spiracles. Spiracles entirely black. From spiracles to ventrad of setigerous tubercle VI a decided light brown. Remainder of venter dark with a brown midventral stripe.

Head white, front medially and laterally black, a strong black stripe from setigerous tubercle A¹ straight posteriorly, growing less intense posteriorly, with dark reticulation posterior to the ocelli and on the posterior margin of the head.

Described from six live larvae collected April 27, 1927, at Clarksville, Tenn. Moths determined by J. McDunnough.

Food: The larva is found in clumps of bluegrass (*Poa pratensis* L.), where it feeds upon both the dead and the live grass.

Distribution: Florida and Tennessee.

Epizeuxis Hübner

The species included in this genus do not form a natural group, and many of the characters used in generic diagnoses are variable within the group. The following characters are constant:

Anal shield normal. Prothoracic spiracle on the line of the posterior margin of the cervical shield. Prespiracular shield rounded, well separated from the cervical shield. Spiracles sometimes elevated at ends, but never emarginate.

Interspace VIII-VIII on abdominal segment 7 less than VIII-VII.

VII on abdominal segment 7, nearer to VIII than to VI.

VII^a not remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae not modified as an anal fork.

Ocelli I and II without a callus between and partially including them.

Arrangement of head setae as follows:

Interspace P¹-P¹ greater than P²-P².

A¹-A²-A³ forming approximately a right angle at A².

As indicated to some extent in the following key to the species, the variation in major characters among the species is greater than should be expected within a genus. *Epizeuxis rotundalis* is unique among the Hypeninae in the character of the labial palpus, in the shortness of the median line of the head, and in the right angled occipital sinus; *lubricalis* and *gopheri* are unique in the character of their setigerous tubercles; *americalis* and *aemula* are unique in the location of setigerous tubercle O²; and *forbesi* and *julia* are very peculiar in having the skin pubescent, while they differ decidedly from each other in some major characters.

Fifteen species are credited to this genus.

KEY TO THE LARVAE OF THE SPECIES

1. Setigerous tubercles I and II very strongly elevated and sub-cylindrical, higher than their basal width, at least on posterior abdominal segments (Pl. XXII, Fig. E; Pl. XXIV, Fig. P). Interspace II to II on abdominal segment 8 less than I to I. Cervical shield with surface irregular. All setae on tarsus slender, pointed (Pl. XXIV, Fig. Q) 2

Setigerous tubercles I and II not very strongly elevated, flat or conical, basal width greater than their height. Interspace II to II on abdominal segment 8 greater than I to I. Surface of

- cervical shield almost regular. Tarsal setae various (Pl. XXIV, Figs. L, O, R) 3
2. Prolegs on abdominal segment 3 non-functional knobs, without crochets. Labial palpus as long as spinneret. Setigerous tubercle VII^a present on abdominal segment 1. Setigerous tubercles II and III directed anteriorly on anterior abdominal segments (Pl. XXII, Fig. E) *lubricalis* Geyer
- Prolegs functional on abdominal segment 3. Labial palpus about one-fourth as long as the spinneret. Setigerous tubercle VII^a absent on abdominal segment 1. Setigerous tubercles II and III not directed anteriorly on anterior abdominal segments. *gopheri* Smith
3. Setigerous tubercle O² more than twice the width of ocellus I removed therefrom. Spiracle with narrow rim (Pl. XXIV, Fig. N, b, c) 4
- Setigerous tubercle O² but little more than width of ocellus I removed therefrom. Spiracles with broader rim (Pl. XXIV, Fig. N, a) 5
4. Prolegs present on abdominal segment 3. Crochets on prolegs short. Median line of head above apex of front very nearly equal to twice the height of front. Head with distinct pigment reticulation. Spiracles broad (Pl. XXIV, Fig. N, b). *aemula* Hübner
- Prolegs absent on abdominal segment 3. Crochets on prolegs long. Median line of head above apex of front equal to one and one-half times height of front. Head without pigment reticulation. Spiracles extremely narrow, slitlike (Pl. XXIV, Fig. N, c) *americana* Guenée
5. Skin obscurely granulose. Prolegs without crochets on abdominal segment 3. Tarsi long, the apical setae slender, pointed (Pl. XXIV, Fig. O). Papilla on basal segment of labial palpus dome-shaped (Pl. XXV, Fig. K). Thorax and anterior abdominal segments not lobed ventro-laterally. *rotundalis* Walker
- Skin pubescent or hairy. Prolegs with crochets on abdominal segment 3. Tarsi short, the inner apical setae spatulate or fan-shaped (Pl. XXIV, Figs. L, R). Papilla on basal segment of labial palpus a slender cone (Pl. XXV, Fig. H). Thorax and anterior abdominal segments lobed ventro-laterally, the segmental incisure deep 6
6. Body broadened on metathorax and anterior abdominal segments. Skin with minute pubescence. Dorsal setae of abdomen pointed, prostrate. Head without pigment reticulation. *forbesi* French

Body not broadened on metathorax and anterior abdominal segments. Skin with coarse barbed pubescence half as long as the setae. Dorsal setae of abdomen capitate, erect. Head with pigment reticulation *julia* Barnes and McDunnough

Epizeuxis gopheri Smith

Head 2.1 mm. broad. Body about 21 mm. long and 3 mm. broad at middle, broadest through abdominal segments 3, 4, and 5. Skin set closely with coarse, abruptly elevated, corrugated granules which are higher than wide and circular in cross section; general color apparently dusky brown, without markings. Setigerous tubercles of body prominent, subconical, except I and II which are strongly elevated and subcylindrical; their setae stout, corrugated, blunt at tip and about one-fourth as long as an abdominal segment. Setigerous tubercle VII^a absent on abdominal segments 1 and 2. Each proleg on all abdominal segments with but three or four crochets of very unequal length and but slightly curved. The two ventral setae on shield of proleg bifid from the base. Claw on leg extremely long and slender. Spinneret extremely long and slender, about four times as long as the labial palpus. Color of spiracles indeterminate. Head brown, set closely with very small rounded granules, the setae as on the body excepting A¹, F¹, and those ventrad of the ocelli, which are pointed at the tip; tubercles rather strongly elevated.

Described from one alcoholic larva in the National Museum collection labelled "Florida (Altamont). From the nest of a burrowing turtle. No. 5921." This specimen is not named in the United States National Museum collection, but from statements of Smith¹ and Hubbard² it seems reasonably certain that it is *gopheri*. The specimen may have been collected at Crescent City, Fla.

Food: Fresh excrement of the gopher turtle (*Gopherus polyphemus*), the larva spending its life far under ground in the burrow of this tortoise.

Distribution: Florida.

Epizeuxis americanalis Guenée

Pl. XXIII, Fig. E; Pl. XXIV, Fig. N, c.

Head 1.3 mm. broad. Body about 18 mm. long and 2 mm. broad at middle, broadening gradually to abdominal segment 7.

¹ Smith, J. B. Description of the Gopher Moth. Can. Ent., vol. 31, p. 84, April, 1899.

² Hubbard, H. G. The Insect Guests of the Florida Land Tortoise. Insect Life, vol. 6, p. 305, 1894.

Skin almost unpigmented, with small, isolated, rounded granules, among which larger rounded granules are scattered; general color a dull, uniform gray sometimes faintly suffused with pinkish, venter sordid gray. No markings. Setigerous tubercles of body large, somewhat elevated, their setae yellow and tapering toward the tip, which is somewhat enlarged, I and II about one-third as long as an abdominal segment, I directed somewhat anteriorly, and II somewhat posteriorly. Spiracles dark with black rims. Head brown, without markings, set closely with small, infuscated, rounded granules.

Described from a large number of live larvae collected during April at Puyallup, Wash. These larvae are abundant in the mounds of the ant *Formica rufa*, a medium-sized mound probably containing several hundred of them. When the mound is disturbed the ants swarm out very pugnaciously, but either ignore these larvae when they are encountered or seize them and carry them into the nest just as is done with the young of the ant. Moths determined by Carl Heinrich.

Food: Materials of the ant mound, including needles of Douglas fir, bark of twigs of Douglas fir, and dead leaves of various kinds. In confinement the larvae consume a remarkably large amount of this débris.

Distribution: Washington, Minnesota, and New York, southward to New Mexico, Texas, and Florida.

Epizeuxis aemula Hübner.

Pl. XXIV, Fig. N, b

Head 1.4 mm. broad. Body about 19 mm. long and 2.6 mm. broad, broadening gradually from prothorax to abdominal segment 8. Skin set very closely with small, rounded granules; general color varying from a moderately dark gray tinged with pinkish to a rosy pink throughout. A distinct dusky middorsal stripe. No other markings, except an indefinite dusky shade subdorsally. Spiracles brownish with black rims. Setigerous tubercles small, but slightly elevated, dark; their setae pale, about twice as long as the width of their tubercles, stout, blunt apically, I directed anteriorly and II posteriorly on the abdomen. Head brownish closely reticulate with fuscous, submedian arcs present dorsally.

Described from four live larvae collected during April at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Our specimens of these larvae were reared on dead leaves. They also have been reported as injurious to corn fodder in Missis-

issippi, and have been beaten from spruce, where the larvae probably were feeding in a webbed-up mass of the dead needles.

Distribution: British Columbia, Minnesota, New York, and Connecticut, southward to Utah, New Mexico, Texas, Mississippi, and Georgia.

Epizeuxis forbesi French (*merricki* Smith)

Pl. XXIV, Fig. L.

Head 1.1 mm. broad. Body about 12 mm. long and 1.6 mm. broad at middle, broadened on mesothorax and metathorax and upon abdominal segments 7 and 8. Skin set very closely with minute, very short pubescence; general color nearly black, the dorsum sometimes paler. The body may be unicolorous except that the venter is less dark than other parts, or the dorsum to well ventrad of setigerous tubercle II may be of a sharply defined paler shade with a dusky middorsal line. Spiracles brownish with black rims, narrow, the inner margin of rim strongly elevated. Setigerous tubercles small, not strongly elevated, fuscous; their setae white, weak, curved, prostrate, rather long, pointed at the tip, I on the abdomen directed antero-dorsally and II postero-dorsally. Head brown, without markings, set closely with coarse, distinctly conical, dark granules.

Described from seven live larvae collected during March at Clarksville, Tenn. Moth determined by Carl Heinrich.

Food: Dead leaves of deciduous trees.

Distribution: New York to Illinois and Tennessee.

Epizeuxis julia Barnes and McDonnough

Pl. XXIV, Fig. R.

Head 1.5 mm. broad. Body about 14 mm. long and 3 mm. broad at middle, distinctly broadest through the metathorax and abdominal segments 1 and 2, and tapering posteriorly. Skin set closely with very minute granules which bear rather coarse, dark, barbed hairs, which are about half as long as the primary setae, and in addition the skin is clothed with an exceedingly fine pubescence; general color a rather dark gray. No markings except a dark middorsal stripe. Setigerous tubercles of body moderately large, the central portion elevated, subconical; their setae slender, somewhat enlarged at tip, two or more times as long as the breadth of their tubercles, I on the abdomen directed somewhat anteriorly and II posteriorly. Tubercles on cervical shield strongly elevated. Spiracles, including rims, brown. Head pale brownish with close dark retic-

ulation, submedian ares on occiput only, an unmarked area above the base of the antenna, granules rather coarse, rounded.

Described from eight live larvae collected during March, April, and May at Clarksville, Tenn. Moth determined by Carl Heinrich.

Food: Bark of fine dead twigs which are in early stages of decay, and perhaps dead leaves also.

Distribution: New York and Tennessee.

Epizeuxis rotundalis Walker

Pl. XXIV, Figs. N, a, O; Pl. XXV, Fig. K

Head 1.8 mm. broad. Body about 22 mm. long and 2.5 mm. broad at middle, broadening very gradually from the prothorax to abdominal segment 8. Skin unpigmented, translucent, set closely with small, colorless, isolated, slightly elevated granules; general color varying from pale gray to dusky gray, depending upon the color of the contents of the alimentary canal. No markings. Prolegs on third abdominal segment distinct but without crochets. Spiracles entirely black. Setigerous tubercles pale fuscous, slightly but distinctly elevated, their setae pale brown, coarse, of nearly uniform diameter throughout but faintly enlarged at tip, I directed slightly anteriorly and II posteriorly on the abdomen. Cervical shield dark fuscous. Head uniform black, without markings, set closely with very fine rounded granules.

Described from many live larvae collected in February and March at Clarksville, Tenn. Moths determined by Carl Heinrich.

Food: This larva lives in the humus beneath leaves in the woods and apparently pupates in such situations without forming a cocoon. It has been taken feeding upon dead coral fungus and on dead leaves, and has been reared on dead leaves.

Distribution: New Hampshire, Connecticut, Pennsylvania, Virginia, and Florida westward to Kansas and Texas.

Epizeuxis lubricalis Geyer

Pl. XX, Figs. C, D; Pl. XXI, Fig. A; Pl. XXII, Fig. E; Pl. XXIII, Fig. F; Pl. XXIV Figs. N, d, P, Q.

Head 1.5 mm. broad. Body about 19 mm. long and 3 mm. broad at middle, abdominal segments of about equal width throughout. Skin closely covered with black rugae; general color blackish, without markings. All setigerous tubercles above the line of the prolegs large, covered with scale-like granules, I and II remarkable subcylindrical appendages (Pl. XXIV, Fig.

P), III similar but much smaller, I dark, II yellowish; their setae stout, slightly clavate, blunt and short; I and II both directed anteriorly on first six abdominal segments, I anteriorly and II posteriorly on segment 7, and both posteriorly on the remaining segments, III oriented the same as I. Spiracles black. Head uniform black, seta A¹ and those below the ocelli pointed at tip, the remainder as on body, with close, elevated, rounded, black granules.

Described from many live larvae collected in October, April, and May at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Always found associated with rotten wood, but whether the larva feeds upon wood or upon fungi associated with it is not known. Larvae have been taken feeding on fungi and also feed to some extent upon green plants in captivity.

Distribution: Nova Scotia, New York, North Carolina, Georgia, and Florida westward to Minnesota, Colorado, New Mexico, and Texas.

Phalaenophana Grote

(*Heterogramma* Guenée)

Metathorax and abdominal segments 1 to 5 of about equal width, segment 7 somewhat broader than 6, segment 8 distinctly narrower than 7. Skin set closely with rather coarse, elevated, isolated granules, which tend to be arranged in transverse linear series interspersed with coarse pale granules. Hind coxae somewhat separated. Prolegs present on abdominal segment 3. Anal shield depressed medially on posterior margin, the median setigerous tubercles distinctly lower than those adjacent. Prothoracic spiracle slightly anterior to the line of the posterior margin of the cervical shield. Prespiracular shield rounded, well separated from the cervical shield. Spiracles elevated and emarginate at ends. Head with close pigment reticulation. Body scarcely reticulate.

Setigerous tubercles of the body distinctly elevated, setae at least twice the width of their tubercles in length, tapering toward the blunt tip, I directed anteriorly on the abdomen and II posteriorly.

IV on prothorax not above center of spiracle.

Interspace VIII-VIII slightly less than VII-VIII on abdominal segment 7.

VII on abdominal segment 7 nearer to VIII than to VI.

VII^a not remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b separate on mesothorax and metathorax.

IV and V separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae close together, modified as an anal fork.

Head with isolated, minute, rounded granules, more strongly elevated dorsally, and not arranged in a reticulate pattern. Arrangement of setigerous tubercles as follows:

Interspace P^1-P^1 somewhat less than P^2-P^2 .

$A^1-A^2-A^3$ forming a slightly obtuse angle at A^2 .

A^3 nearer to O^2 than to L^1 .

F^1 scarcely nearer to the margin of the front than to F^a .

P^1 about twice as near to the median lines as to L^1 .

This genus includes two species. The larva of but one of these is known.

Phalaenophana pyramusalis Walker

Pl. XXIII, Fig. H; Pl. XXIV, Fig. F.

Head 1.3 mm. broad. Body about 16 mm. long and 2.4 mm. broad. General color dark gray or dull black.

Throughout is an undercolor of obscure green suffused and splotched, rather than reticulate, with infuscated red, interspersed with pale flecks formed by coarse pale granules. Middorsal pale line absent. Coloration intensified on anterior half of abdominal segments in a dark spot between setigerous tubercles I, and forming a continuous middorsal stripe on abdominal segments 7, 8, and 9, where it is bordered laterally by a conspicuous, curved, pale mark beginning narrowly between III and the spiracle on segment 7, including II of this segment, and I and II of the following segments. On each abdominal segment an infuscated red mark arising ventrad of IV and broadening obliquely upward ventrad of III to the anterior margin of the segment, where the mark fuses with the general coloration. Spiracles small, entirely black, set in small pale areas. Traces of a band of yellowish flecks ventrad of the spiracles. Red less infuscated and green more evident ventrally.

Setigerous tubercles in general black with pale apices and set in pale circles, I black, at least on dorsal margin, with the apex white, II white with the dorsal margin dusky, setae infuscated at base and paler apically.

Head pale greenish, submedian arcs indicated anteriorly and on the occiput, a narrow unmarked area above the base of the antennae to A^3 , adfrontal areas black, remainder of head closely reticulate with black.

Described from fifteen live larvae collected in October at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Larvae are found in cool, moist situations such as are preferred by jewel weed (*Impatiens*), where they feed on forest leaves black with decay.

Distribution: New York and District of Columbia westward to Missouri and Texas.

Tetanolita Grote

Body not broadened through the mesothorax and metathorax. Abdominal segments of about equal width to 7, which is slightly broader than the preceding segment. Skin set closely with small, rounded granules, interspersed with coarse, rounded or subconical granules, not arranged in a reticulate pattern. Hind coxae well separated. Prolegs present on abdominal segment 3. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Spiracles elevated and but slightly emarginate at ends. Head with distinct, but not prominent, pigment reticulation. Dorsum of body with or without reticulation.

Setigerous tubercles of body rather strongly elevated, with a subapical angulation. Setae I and II twice as long as the width of their tubercles, stout and but very slightly enlarged apically, I directed anteriorly and II posteriorly on the abdomen.

IV on the prothorax above the center of the spiracle.

VII on abdominal segment 7 nearer to VIII than to VI.

VII^a not remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b separate on mesothorax and metathorax.

IV and V separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae apparently developed as an anal fork.

Head with isolated, rounded granules not arranged in a reticulate pattern, and not enclosing pits.

Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ distinctly greater than P²-P².

A¹-A²-A³ forming a very obtuse angle at A².

A³ distinctly nearer to O² than to L¹.

F¹ not nearer to margin of front than to F^a.

Four species are credited to this genus.

Tetanolita palligera Smith

Head 1.3 mm. broad. Body about 14 mm. long and 2 mm. broad at middle. General color dusky gray.

Dorsum, barely including setigerous tubercle II, pale with a middorsal black stripe and faintly tinged with reddish at the juncture of the segments. No subdorsal pale line. Supraspi-

raacular area dark, with isolated pale flecks. Spiracles entirely black. A yellowish broken line of flecks below the spiracles. Venter livid, marked with reddish and flecked with yellowish. Setigerous tubercles black, surrounded by a pale or yellowish area made up of large granules; their setae long, yellowish, stout, and but very slightly enlarged apically. Head pale brownish, not prominently but nevertheless distinctly reticulate with dark brown.

The character of the anal shield and subanal setae was not noted, but in a single larva apparently of this genus, taken at Clarksville, Tennessee, the anal shield is depressed on the posterior margin, with the median setigerous tubercles somewhat below those adjacent, and the subanal setae are very close together and modified as an anal fork. The Clarksville specimen differs in having close, distinct pigment reticulation on the body, and probably is *mynesalis* Walker.

Described from one live larva collected April 18, 1930, at Yakima, Wash. Moth determined by Carl Heinrich.

Food: Taken among dead apple leaves.

Distribution: California and Washington.

Renia Guenée

Body of about equal width from metathorax to sixth abdominal segment or broadening gradually posteriorly to this segment. Segments 7 and 8 abruptly widened. Skin granules very fine, slightly isolated, tending to be arranged in lines, sometimes in a reticulate pattern. Hind coxae very widely separated. Prolegs present on abdominal segment 3. Anal shield normal. Prothoracic spiracle anterior to the line at the posterior margin of the cervical shield. Prespiracular shield elongate, wedge-shaped, very narrowly separated from, or connate with, the cervical shield. Spiracles elevated and emarginate at the ends. Head without pigment reticulation. Markings of body usually obscure, sometimes sharply defined.

Setigerous tubercles of body distinctly elevated. Setae I and II usually blunt, or clavate, I at least slightly longer than the width of its tubercle, II usually twice as long, I directed anteriorly and II posteriorly.

IV on prothorax above the middle of the spiracle.

Interspace VIII-VIII on abdominal segment 7 usually less than VIII-VII.

VII on abdominal segment 7 decidedly nearer to VIII than to VI.

VII^a not remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b not confluent on mesothorax and metathorax.

IV and V not confluent on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Head with coarse contiguous granules arranged dorsally in a reticulate pattern enclosing pits. Arrangement of setigerous tubercles as follows:

Interspace P^1 - P^1 distinctly greater than P^2 - P^2 .

A^1 - A^2 - A^3 forming a very obtuse angle at A^2 .

A^3 usually nearer to O^2 than to L^1 .

F^1 scarcely nearer to the margin of the front than to F^a .

P^1 but slightly, if any, nearer to the median line than to L^1 .

Fourteen species are placed in this genus, the larvae of six of which are here described.

KEY TO LARVAE OF THE SPECIES

1. Dorsal setae of body acutely, abruptly pointed, I no longer than the width of its tubercle, II but little longer than the width of its tubercle (Pl. XXIV, Fig. H). Setigerous tubercle II paler than I. With a bright red middorsal line.

discoloralis Guenée

Dorsal setae of body blunt or clavate at tip, I usually distinctly longer than the width of its tubercle, II twice as long as the width of its tubercle (Pl. XXII, Fig. E). Setigerous tubercles I and II unicolorous black, with a dusky reddish or fuscous middorsal line or none 2

2. Setigerous tubercles I and III with their bases confluent on abdominal segment 9 4
- Setigerous tubercles I and III well separated, distinct, on abdominal segment 9 (Pl. XXI, Fig. H) 3

3. Setigerous tubercles I and II with a subapical angulation (Pl. XXIV, Fig. E). Body with a dusky middorsal line. Head pale brownish with slender black submedian arcs. Spiracles pale with black rims *factiosalis* Walker

Setigerous tubercles I and II conical or nearly so. Body without a middorsal pigment line. Head dusky brownish with a pale area above the base of the antennae, without submedian arcs. Spiracles brownish with black rims *sobriialis* Walker

4. Seta I stout, clavate, but little longer than the width of its tubercle. Body setae white, in live larvae. Venter marked with bright red from the spiracles ventrally. Spiracles pale with black rims *flavipunctalis* Geyer

Seta I rather slender, scarcely clavate, at least twice as long as the width of its tubercle. Body setae black or brown, in live larvae. Venter marked with dusky reddish from the spiracles ventrally. Spiracles brownish with black rims 5

5. Prespiracular shield connate with the cervical shield (Pl. XXIII, Fig. D). Head unicolorous dusky brownish except for dark spots at setigerous tubereles *salusalis* Walker
 Prespiracular shield narrowly separated from the cervical shield (Pl. XXIII, Fig. B). Head pale brown with a dusky spot beside the base of the front and with dark spots at the setigerous tubereles *fraternalis* Smith

Renia factiosalis Walker

Pl. XXIV, Fig. E.

Head 1.3 mm. broad. Body about 16 mm. long and 2.3 mm. broad. General color dusky.

Dorsally to setigerous tubercle III dusky, tinged rather than marked with reddish, with a strong dusky stripe middorsally and a distinct, somewhat broken, pale line ventrad of setigerous tubercle II. Spiracles pale with black rims. Abruptly much paler ventrad of the spiracles, the ventral tubercles set in pale spots encircled with reddish.

Setigerous tubercles fuscous. Their setae pale, stout, blunt at tips, tending to be set on the posterior face of the tubercles and about twice as long as the width of the tubercles.

Head pale brownish, the submedian arcs, which extend posteriorly along the margin of the occipital angle, and a stripe posterior to the ocelli through O^2 to the posterior margin, black.

Described from five live larvae collected May 1927, at Lexington, Ky., by K. B. McKinney and the writer. Moth determined as belonging to this species by F. H. Benjamin.

Food: Dead leaves of deciduous trees.

Distribution: Nova Scotia to Virginia and westward to Kentucky.

Renia sobrialis Walker

Pl. XXII, Fig. F; Pl. XXIV, Fig. M, *a*.

Head 1.5 mm. broad. Body about 15 mm. long and 3.5 mm. broad. General color dark, approaching black.

Body, dorsad of the line of the prolegs, dusky, obscurely marked with livid reddish which appears ventrally as a bright red reticulation. Just ventrad of setigerous tubercle II is a broken pale line more pronounced at the juncture of the segments and marked with red. No middorsal stripe. Cervical shield nearly black. Spiracles brown with black rims.

Setigerous tubercles shining black. Setae I to V slightly enlarged toward their tips, I (the shortest) at least twice as long as the breadth of its tubercle.

Head dusky infuscated brown except for the front, a stripe arising above the base of the antennae and extending to P², and a spot on the posterior margin, which are pale.

Described from eight live larvae collected February 1927, at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Dead leaves of deciduous trees.

Distribution: Nova Scotia to Virginia and westward to Tennessee and Mississippi; also reported from Colorado.

Renia salusalis Walker

Pl. XXIII, Fig. D.

Head 1.5 mm. broad. Body about 17 mm. long and 3.5 mm. broad. General color dusky brown.

An obscure dusky middorsal line. Markings of body an obscure reddish, more evident from the spiracles ventrally. Subdorsal pale line not indicated except faintly at the juncture of the segments. Cervical shield brownish. Spiracles brownish with black rims.

Setigerous tubercles black. Setae dusky or black, I to V slightly enlarged toward their tips, I (the shortest) at least twice as long as the breadth of its tubercle.

Head unicolorous dusky brownish without traces of pale stripes, the setigerous tubercles in dark spots.

Described from five live larvae collected February 1927, at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Dead leaves of deciduous trees.

Distribution: New York to Florida and westward to Colorado.

Renia fraternalis Smith

Head 1.4 mm. broad. Body about 15 mm. long and 2.5 mm. broad. General color dusky.

Dorsal coloration made up of obscure infuscated reddish and pale spots. A series of subdorsal pale spots at the juncture of the abdominal segments. Cervical shield brown. Spiracles very dark brownish with black rims. Venter paler than the dorsum, marked throughout with dark red.

Setigerous tubercles black. Setae pale brownish, but slightly enlarged toward their tips, I (the shortest) twice as long as the width of its tubercle.

Head brown, with a dilute fuscous spot opposite the base of the front and an indefinite fuscous line from O² to the posterior margin. Setigerous tubercles in dark spots. Adfrontal areas infuscated. No other markings.

Described from three live larvae collected March 1927, at Clarks-ville, Tenn. Moth determined by H. G. Dyar.

Food: Dead leaves of deciduous trees.

Distribution: North Carolina to Florida and westward to Tennessee.

Renia flavipunctalis Geyer

Pl. XXIII, Fig. G.

Head 1.5 mm. broad. Body about 16 mm. long and 3.5 mm. broad. Skin finely reticulate with fine raised lines, the reticulation irregularly replaced, especially on the dorsum, by corrugated subconical granules. General color dusky brownish.

Dorsal coloration made up of rather sharply defined dusky reddish and yellow spots. A distinct dusky reddish middorsal line. Traces of a yellow line between setigerous tubercles II and III, also a similar one ventrad of the spiracles. Setigerous tubercles black, set in yellow spots throughout. Venter pale marked with bright red. Spiracles pale brownish with black rims.

Setigerous tubercles strongly elevated. Setae white, I clavate, II stout and not tapering toward the blunt tip, I slightly longer than the width of its tubercle. II twice as long as the width of its tubercle, I directed anteriorly and II posteriorly on the abdomen.

Head coarsely granulose, with obscure pits, brown, with dusky areas beside the front which may reach the posterior margin. No other markings.

Described from twenty-five live larvae collected at Clarks-ville, Tenn., March 1927. Moths determined by Carl Heinrich.

Food: Larvae are found among drifted dead leaves in deciduous forests and have been reared on dead oak leaves.

Distribution: Canada to Vermont, Maryland, and North Carolina and westward to Michigan, Kansas, New Mexico, and Texas.

Renia discoloralis Guenée

Pl. XX, Figs. E, F; Pl. XXI, Fig. H; Pl. XXIII, Fig. B; Pl. XXIV, Fig. H; Pl. XXV, Fig. B.

Head 1.7 mm. broad. Body about 22 mm. long and 4 mm. broad. Skin with a fine reticulation of obscure elevated lines. General color effect light brown.

Dorsal coloration made up of a bright red reticulation on a yellowish ground, including a red middorsal stripe. A yellow

line extending from ventrad of setigerous tubercle II diagonally upward to and including tubercle II of the following segment. Splotches of yellow throughout. Setigerous tubercle in yellow spots throughout, I black, II brownish. Spiracle pale yellowish with black rims. Venter paler than the dorsum, marked with bright red.

Setigerous tubercles rather strongly elevated. Setae I to V stout, heavy, suddenly constricted near the apex to a sharp point, I no longer than the width of its tubercle, II somewhat longer than the width of its tubercle.

Head coarsely granulose, with obscure pits, brown, with distinct dusky submedian arcs. Adfrontal areas dusky. No other markings.

Described from twenty-six live larvae collected in February and March 1927, at Clarksville, Tenn. Moths determined by Carl Heinrich.

Food: The larva occurs among dead leaves, upon which it has been reared.

Distribution: New York to North Carolina and westward to Kentucky and Tennessee.

Bleptina Guenée

Body gradually increasing in width from the prothorax posteriorly. Abdominal segments 7 and 8 abruptly wider than the preceding segments. Character of skin granules variable. Hind coxae very widely separated. Prolegs present on abdominal segment 3. Anal shield normal. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Prespiracular shield well rounded, well separated from the cervical shield. Spiracles elevated and emarginate at ends. Head and body without pigment reticulation.

Setigerous tubercles of body gently convex, nearly flat. Setae I to V very short, and extremely strongly clavate or capitate, scarcely longer than the width of their tubercles, I and II upright.

IV on prothorax below the center of the spiracle.

Interspace VIII-VIII on abdominal segment 7 less than VIII-VII.

VII on abdominal segment 7 decidedly nearer to VIII than to VI.

VII^a not remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b not confluent on mesothorax and meta thorax.

IV and V not confluent on mesothorax and metathorax.

No confluent setigerous tubercles in the VII group.

Subanal setae not modified as an anal fork.

Head with rounded granules, either coarse or minute, sometimes arranged in a reticulate pattern dorsally, with dark impressed spots. Arrangement of setigerous tubercles as follows:

Interspace P^1 - P^1 greater than P^2 - P^2 .

A^1 - A^2 - A^3 forming a very obtuse angle at A^2 .

A^3 somewhat nearer to O^2 than to L^1 .

F^1 much nearer to the margin of the front than to F^a .

P^1 but slightly, if at all, nearer to the median line than to L^1 .

Six species are credited to this genus.

KEY TO LARVAE OF SPECIES

1. Skin very minutely granulose, appearing smooth. Spiracles bright yellow. Dorsal setae of body yellow. Setigerous tubercles of body in reddish circles *inferior* Grote
Fine granules of skin interspersed with very coarse, corrugated, elevated, pale granules. Spiracles dark regularly flecked with golden brown. Dorsal setae of body pale. No special markings about the setigerous tubercles 2
2. Ground color of head brown *caradrinalis* Guenée
Ground color of head black *medialis* Smith

Bleptina inferior Grote

Pl. XXIII, Fig. C ; Pl. XXIV, Figs. I, M, b.

Head 1.9 mm. broad. Body about 15 mm. long and 3 mm. broad at middle. General color black or dark infuscated brown.

A subdorsal stripe ventrad to setigerous tubercle II and circles about tubercles I to VI, dull reddish. Venter dusky. No other markings. Dorsal setae yellow. Spiracles bright conspicuous yellow with black rims. Head dull brownish, with numerous dark depressions, bases of setae and margin of front dark. No other markings.

Described from twenty live larvae collected in February at Clarksville, Tenn. Moths determined by F. H. Benjamin.

Food: Dead leaves of oak and other trees.

Distribution: Virginia, Georgia, and Florida westward to Missouri, Tennessee, and Texas.

Bleptina caradrinalis Guenée

Pl. XXI, Fig. E.

Head 1.5 mm. broad. Body about 18 mm. long and 3.5 mm. broad at middle. General color varying from nearly black to

dark infuscated brown, the skin having a finely speckled appearance owing to the presence of coarse pale granules.

The coloration may be nearly uniform throughout except for a pale midventral stripe, or there may be a dark middorsal stripe, four small dorsal pale spots at posterior margins of abdominal segments, and a pale to reddish stripe dorsad of the spiracles. Dorsal setae pale. Spiracles dark, their centers regularly flecked with golden brown.

Head brown with close-set dark depressions, a pale stripe extending along the adfrontal sutures and upon the median line, margin of front dark, the granules arranged in a reticulate pattern dorsally, enclosing pits.

Described from thirty-four live larvae collected in February at Clarksville, Tenn. Moths determined by F. H. Benjamin.

Food: Dead leaves of deciduous trees.

Distribution: British Columbia, North Dakota, Minnesota, New York, and New Hampshire southward to Arizona, New Mexico, Texas, Mississippi, and Alabama.

Bleptina medialis Smith

Head 1.5 mm. broad. Body about 12 mm. long and 2.5 mm. broad at middle. General color black, both dorsally and ventrally.

Four dorsal pale spots at juncture of abdominal segments. A pale stripe above the spiracles. Cervical shield pale with a broad black subdorsal stripe. Spiracles dark, regularly flecked with golden brown. Head black.

Two larvae have been collected in March at Clarksville, Tenn. The one from which this description was made probably was immature. Moth determined by F. H. Benjamin.

Food: Dead leaves of deciduous trees.

Distribution: Florida and Tennessee.

Lascoria Walker

Body broadest through anterior abdominal segments and tapering distinctly posteriorly, with a middorsal hump on abdominal segment 8. Skin with minute, almost contiguous, rounded granules. Hind coxae somewhat separated. Prolegs present on abdominal segment 3. Anal shield with the posterior setigerous tubercles somewhat produced. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Spiracles very slightly elevated and not emarginate at

ends. Prespiracular shield well separated from the cervical shield. Head and body with pigment reticulation.

Setigerous tubercles of body of moderate size, but slightly elevated, except II on abdominal segment 8, which is conspicuously large, bluntly subconical and strongly elevated, with a subsidiary area at apex in which the seta is inserted. Setae slender, twice as long as the width of their tubercles, pointed at tip, I nearly upright, II directed slightly posteriorly.

IV on prothorax above center of spiracle.

Interspace VIII-VIII on abdominal segment 7 equal to VIII-VII.

VII on abdominal segment 7 much nearer to VIII than to VI.

VII^b somewhat nearer to VII^c than to VIII on abdominal segment 1.

I^a and I^b well separated on mesothorax and metathorax.

IV and V separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group on abdominal segments 1 and 2. Subanal setae not modified as an anal fork.

Head with minute, contiguous granules not arranged in a reticulate pattern. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ greater than P²-P².

A¹-A²-A³ forming a right angle at A².

A³ distinctly nearer to O² than to L¹.

F¹ slightly nearer to F^a than to lateral margin of front.

P¹ slightly nearer to median line of head than to L¹.

This genus includes two species, but one of which is known in the larval stage.

Lascoria ambigualis Walker

Head 1.6 mm. broad. Body about 13 mm. long and 2 mm. broad at middle. General color dark.

Body ground color pale, reticulate throughout with fuscous, somewhat paler and tinged with dull red ventrad of the spiracles. Middorsal pale line evident on anterior abdominal segments as a large V-shaped pale mark at posterior margin of segments, but strong and continuous posteriorly. Indefinite pale areas at juncture of abdominal segments in the line of the spiracles and dorsad of setigerous tubercle II. No other markings.

Setigerous tubercles black, round in outline, but slightly elevated, except II on abdominal segment 8, which is conspicuously large, bluntly subconical, and strongly elevated. The setigerous tubercles are peculiar in that each bears an apical,

brown, subsidiary tubercle in which the seta is inserted. Spiracles extremely narrow, blackish brown with black rims.

Head white, faintly tinged with green, an unmarked area mediad of the ocelli and including setigerous tubercle L^1 ; otherwise closely reticulate with black. Submedian arcs not represented except in a spot including A^1 and A^2 . Front white with two black vertical stripes.

Described from two live larvae collected November 18, 1931, at Washington, D. C., by J. U. Gilmore. Moth determined by F. H. Benjamin.

Food: Taken on cultivated *Chrysanthemum*.

Distribution: Canada, New York, and the District of Columbia to the Gulf of Mexico and westward to the Central States and Texas.

Palthis Hübner

Body slightly broadened on the metathorax, but not on abdominal segments 7 and 8, with a decided middorsal hump on abdominal segment 8, including I. Skin set with short, stout, spine-like granules. Hind coxae widely separated. Prolegs present on abdominal segment 3. Anal shield normal. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Prespiracular shield rounded, well separated from the cervical shield. Spiracles elevated and emarginate at ends. Head with pigment reticulation. Dorsum of body obscurely reticulate.

Setigerous tubercles of body distinctly elevated. Setae slender, pointed at tip, somewhat longer than the width of their tubercles, I directed anteriorly and II posteriorly.

IV on prothorax scarcely above the center of the spiracle.

Interspace VIII-VIII slightly less than VIII-VII on abdominal segment 7.

VII on abdominal segment 7 somewhat nearer to VIII than to VI.

VII^c absent on abdominal segment 1.

I^a and I^b separate on mesothorax and metathorax.

IV and V separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae not modified as an anal fork.

Head with small, isolated, rounded granules arranged in a reticulate pattern dorsally. Arrangement of setigerous tubercles as follows:

Interspace P^1-P^1 greater than P^2-P^2 .

$A^1-A^2-A^3$ forming a right angle at A^2 .

A^3 about twice as near to O^2 as to L^1 .

F¹ not nearer to the margin of the front than to F^a.

P¹ approximately equidistant from the median line and L¹.

This genus includes two species.

Larvae of both of the species of *Palthis* have been seen but the specimens are not in good condition for description. In each of these species there is a pale or yellowish mark arising as a distinct narrow stripe at the anterior margin of abdominal segment 7, extending obliquely upward between the spiracle and setigerous tubercle III and broadening posteriorly until it occupies the area between I, II and III on abdominal segment 8. In *angulalis* Hübner the body is obscurely reticulate with reddish while in *asopialis* Guenée this reticulation is fuscous.

But two larvae of *angulalis* have been seen. These were collected, one from *Amelanchier florida* and one from blackberry, by Wm. W. Baker at Puyallup, Washington, in September. Bird¹ has reared *angulalis* from *Prunus virginiana* L. Two larvae of *asopialis* have been examined. One of these was swept from Coral Berry (*Symphoricarpos orbiculatis* Moench.) at Clarksville, Tenn., on October 3 while the second specimen was collected by K. B. McKinney at Moss Bluff, Texas, in October.

Both species are said to have the same range which extends from New York, Maryland, North Carolina and Georgia westward to British Columbia, Washington, Manitoba, Minnesota, Missouri and Texas except that *asopialis* is not reported from British Columbia, Washington and Manitoba.

Phalaenostola Grote

Body slightly broadest through anterior abdominal segments. Skin with small, isolated, rounded granules, interspersed with coarse, irregular, corrugated, subconical granules. Hind coxae rather close together. Prolegs present on abdominal segment 3. Anal shield depressed medially on posterior margin, the median setae distinctly below the adjacent setae. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Prespiracular shield rounded, well separated from the cervical shield. Spiracles elevated and emarginate at ends. Head with sparse pigment reticulation. Dorsum of body not reticulate.

¹ Bird, Ralph D. Notes on Insects Bred from Native and Cultivated Fruit Trees and Shrubs of Southern Manitoba. Can. Ent., vol. 57, No. 6, p. 125, June 1927.

Setigerous tubercles distinctly elevated. Setae rather stout, pointed at tip, somewhat more than the width of their tubercles in length, I and II both directed posteriorly.

IV on prothorax below the center of spiracle.

Interspace VIII-VIII much less than VIII-VII on abdominal segment 7.

VII on abdominal segment 7 nearer to VIII than to VI.

VII^a remote from VII^b and VII^c on abdominal segment 1.

VII^c nearly in a transverse line with VII^a.

I^a and I^b separate on mesothorax and metathorax.

IV and V separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae modified as an anal fork.

Head with small, isolated, rounded granules, not arranged in a reticulate pattern. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ greater than P²-P².

A¹-A²-A³ forming a right angle at A².

A³ slightly nearer to O² than to L¹.

F¹ scarcely nearer to the margin of the front than to F^a.

P¹ somewhat nearer to L¹ than to the median line.

This genus includes but one species.

Phalaenostola laurentioides Grote

Pl. XXIV, Fig. A.

Head 1.2 mm. broad. Body about 15 mm. long and 2 mm. broad at middle. General color brownish gray.

A strongly marked dark middorsal stripe. Body dorsad of the spiracles with many pale flecks which are not arranged in lines. A red stripe just ventrad of setigerous tubercle II, another dorsad of III. Ventrad of III to and including the spiracles more infuscated, especially posteriorly and reticulate with red. Spiracles entirely black. Traces of a pale subspiracular stripe bordered ventrally anteriorly by a red line, and bearing oblique red stripes posteriorly. Venter reticulate with red, with a bright red midventral stripe. Head white reticulate with dilute black, adfrontal areas dilute black.

Described from eleven live larvae collected during April at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Larvae taken in clumps of bluegrass (*Poa pratense*) and among weed litter. Feed upon both live and dead bluegrass, dead forest leaves, and live clover.

Distribution: New York, Ohio, Indiana, Tennessee, Missouri, and Kansas.

Philometra Grote

Body very slightly broadened on the metathorax and abdominal segments 7 and 8. Skin set irregularly with a mixture of fine granules and coarse subconical granules. Hind coxae somewhat separated. Prolegs present on abdominal segment 3. Anal shield depressed medially on posterior margin, the median posterior setae distinctly below the adjacent setae. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Prespiracular shield well rounded, well separated from the cervical shield. Spiracles elevated and emarginate at ends. Head with distinct pigment reticulation. Dorsum of body not reticulate.

Setigerous tubercles of body strongly elevated. Setae set rather on the posterior face of the tubercles, stout, pointed at the tip, at least twice as long as the width of their tubercles, I and II both directed supinely almost parallel with the dorsum.

IV on prothorax not above the center of the spiracle.

Interspace VIII-VIII less than VIII-VII on abdominal segment 7.

VII on abdominal segment 7 decidedly nearer to VIII than to VI.

VII^a not remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b separate on mesothorax and metathorax.

IV and V separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae modified as an anal fork.

Head with rather small, rounded granules arranged in a reticulate pattern dorsally. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ distinctly greater than P²-P².

A¹-A²-A³ forming approximately a right angle at A².

A³ slightly nearer to O² than to L¹.

F¹ scarcely nearer to margin of front than to F^a.

P¹ somewhat nearer to L¹ than to median line.

This genus includes three species, of which we have seen the larva of but one.

Philometra metonalis Walker

Pl. XXIV, Fig. B.

Head 1.2 mm. broad. Body about 20 mm. long and 2.4 mm. broad at middle. General color dark gray.

Dorsum to just ventrad of setigerous tubercle II sordid pale with a prominent dark middorsal stripe and sparse transverse reddish fuscous markings midway between I and II. From ven-

trad of II to and partially including the spiracles infuscated, tinged with reddish, darker ventrally. Spiracles entirely black. Abruptly much paler ventrad of the spiracles to VI and marked with reddish which tends to form oblique stripes posteriorly. Venter below VI much infuscated, as dark as the supra-spiracular area, with a dull red midventral line. Setigerous tubercles dark, their setae pale. Head pale, closely reticulate with dilute black, without submedian ares.

Described from four larvae; two collected at Clarksville, Tenn., in April, and two collected at Lexington, Ky., in May. Moths determined by H. G. Dyar.

Food: Dead bluegrass (*Poa pratense*) and dead leaves of deciduous trees.

Distribution: Nova Scotia, New York, Pennsylvania, and Virginia westward to Kentucky and Tennessee; also reported from Alberta and British Columbia.

Hormisa Walker

Body somewhat broadened through anterior abdominal segments, tapering posteriorly. Skin with fairly large subcylindrical granules in pale flecks. The darker areas with smaller, strongly convex granules. Hind coxae somewhat separated. Prolegs present on abdominal segment 3. Anal shield tapering posteriorly, the posterior setigerous tubercles very strongly produced. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Prespiracular shield rounded, well separated from the cervical shield. Spiracles elevated and emarginate at ends. Head with pigment reticulation. Body not reticulate.

Setigerous tubercles of body nearly flat. Setae slender, pointed, scarcely twice as long as the width of their tubercles, I and II both directed slightly posteriorly.

IV on prothorax well below center of spiracle.

Interspace VIII-VIII much less than VIII-VII on abdominal segment 7.

VII^a remote from VII^b and VII^c on abdominal segment 1.

VII^c anterior to VII^a on abdominal segment 2.

VII^b approximately equidistant from VII^c and VIII.

I^a and I^b separate on mesothorax and metathorax.

IV and V separate on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae not modified as an anal fork.

Head with isolated, minute granules, not arranged in a reticulate pattern. Arrangement of setigerous tubercles as follows:

Interspace P^1-P^1 greater than P^2-P^2 .

$A^1-A^2-A^3$ forming approximately a right angle at A^2 .

A^3 slightly nearer to O^2 than to L^1 .

F^1 nearer to F^a than to the margin of front.

P^1 slightly nearer to L^1 than to the median line.

This genus includes four species, the larva of but one of which has been examined.

Hormisa litophora Grote

Pl. XXI, Fig. G; Pl. XXIV, Fig. C.

Head 1.6 mm. broad. Body about 20 mm. long and 2.2 mm. broad at middle. General color gray, matching dead, weathered bluegrass.

A distinct but not very prominent dark middorsal stripe bordered laterally by aggregations of pale flecks. A pale line of flecks ventrad of setigerous tubercle I, and a broader one ventrad of II, both much stronger posteriorly. All of these pale lines alternating with obscure red lines. Supraspiracular area infuscated, somewhat paler ventrally and more strongly pigmented posteriorly. Spiracles entirely black. A pale subspiracular stripe bordered ventrally anteriorly by a reddish stripe and bearing oblique reddish stripes posteriorly. A broken dusky reddish midventral stripe on abdominal segments 1 and 2. Setigerous tubercles black, their setae small. Head white, with the adfrontal areas, two straight reticulate stripes above the front, a reticulate stripe between A^2 and A^3 and extending to the posterior margin, and a reticulate stripe posterior to the ocelli, dilute black.

Described from four live larvae collected during April at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Both live and dead bluegrass (*Poa pratense*) and also green clover.

Distribution: New York and Connecticut to Tennessee.

Zanclognatha Lederer

Body broadened on the mesothorax and metathorax and on abdominal segments 7 and 8. Skin granules small, rounded or flat. Hind coxae very widely separated. Prolegs present on abdominal segment 3. Anal shield normal. Prothoracic spiracle anterior to the line of the posterior margin of the cervical shield. Prespiracular shield well rounded, well separated from cervical shield. Head and body with distinct pigment reticulation. Spiracles elevated and emarginate at ends.

Setigerous tubercles of body round in outline, gently convex in profile, nearly flat. Setae very short and pointed at tip, scarcely as long as the width of their tubercles, I and II both directed slightly posteriorly.

IV on prothorax below center of spiracle.

Interspace VIII-VIII on abdominal segment 7 less than VIII-VII.

VII on abdominal segment 7 decidedly nearer to VIII than to VI.

VII^a not remote from VII^b and VII^c on abdominal segment 1.

I^a and I^b not confluent on mesothorax and metathorax,

IV and V not confluent on mesothorax and metathorax.

No confluent setigerous tubercles in VII group.

Subanal setae not modified as an anal fork.

Head with fine, rounded contiguous granules not arranged in a reticulate pattern. Spinneret short and stout. Arrangement of setigerous tubercles as follows:

Interspace P¹-P¹ distinctly greater than P²-P².

A¹-A²-A³ forming approximately a right angle at A².

A³ distinctly nearer to O² than to L¹.

F¹ approximately equidistant between lateral margin of front and F^a, or nearer to margin of front.

P¹ approximately equidistant from the median line and L¹, or nearer to L¹.

This genus is very near *Chytolita*, and the two may not be distinct. It includes thirteen species, of which the following have been examined:

KEY TO LARVAE OF THE SPECIES

1. With a dark middorsal stripe. Spiracles entirely black. Pigment reticulation of body fuscous or dull reddish 2
Without a dark middorsal stripe. Spiracles pale with black rims. Pigment reticulation of body bright red 3
2. Pigment reticulation of body fuscous, with conspicuously coarser pale granules in the interstices of the reticulation.
pedipilalis Guenée
Pigment reticulation of body dull reddish, without coarser pale granules in the interstices of the reticulation.
lituralis Hübner
3. With a pale spot dorsad of setigerous tubercle II throughout and posterior to III on abdominal segment 7*cruralis* Guenée
Without a pale spot dorsad of setigerous tubercle II or posterior to III *obscuripennis* Grote

Zanclognatha obscuripennis Grote

Head 2 mm. broad. Body about 13 mm. long and 2.5 mm. broad.

Coloration made up of a bright red reticulation with the interstices yellow. No dark middorsal stripe and no pale spots dorsad of setigerous tubercle I or posterior to III. Spiracles pale with black rims. Head with coarse reddish brown reticulation.

Described from two inflated larvae in the United States National Museum collection labelled "July 26, 1882. No. 2807."

Food: Dead leaves.

Distribution: New York, North Carolina, and Alabama.

Zanclognatha lituralis Hübner

Head 1.5 mm. broad. Body about 17 mm. long and 3 mm. broad. General color dusky brownish to purplish.

Coloration made up of a dull red reticulation with the interstices not yellow but pale. A dusky middorsal stripe more evident on anterior half of each abdominal segment. A round, definite, pale area surrounding setigerous tubercle I. A pale spot dorsad of II throughout and posterior to III on abdominal segment 7. Spiracles entirely black. Setigerous tubercles pale fuscous. Head pale with brownish fuscous reticulation.

Described from three live larvae collected in February at Clarksville, Tenn. Moths determined by F. H. Benjamin.

Food: Dead leaves of deciduous trees.

Distribution: New Hampshire, Pennsylvania, North Carolina, and Florida westward to Tennessee and Texas.

Zanclognatha cruralis Guenée

Pl. XXIII, Fig. A; Pl. XXIV, Fig. M, c; Pl. XXV, Fig. F.

Head 2 mm. broad. Body about 16 mm. long and 3.5 mm. broad. General color pale leaf brown tinged with pink.

Coloration made up of a bright red reticulation with the interstices pale yellowish brown. An indefinite, sinuous, pale line ventrad of setigerous tubercle II. A pale spot dorsad of setigerous tubercle II throughout and posterior to III on abdominal segment 7. No trace of a middorsal dusky stripe. Setigerous tubercle I not in a definite, round, pale area. Spiracles pale brownish with black rims, the extreme edge of the elevated rim pale brownish. Head pale, closely reticulate with brownish red.

Described from twelve live larvae collected during February and March at Clarksville, Tenn. Moths determined by H. G. Dyar.

Food: Dead leaves of deciduous trees.

Distribution: Nova Scotia, New York, Maryland, and North Carolina westward to Illinois and Tennessee, also reported from New Mexico.

Zanclognatha pedipilalis Guenée

Pl. XXIV, Fig. J.

Head 1.8 mm. broad. Body about 20 mm. long and 3 mm. broad. General color sordid brownish.

Dorsal coloration made up of a rather coarse-meshed infuscated brown reticulation with the interstices yellowish. A strong, continuous, dark middorsal stripe bordered by indefinite pale stripes formed by a concentration of pale flecks in this area. A dark dash from each abdominal spiracle directed diagonally upward and forward to slightly beyond the margin of the preceding segment. An indefinite pale spot dorsad of setigerous tubercle I throughout and posterior to III on abdominal segment 7. Spiracles deep brown or black. Midventral reticulation bright red. Ground color of head pale, with traces of dark submedian arcs anteriorly, closely reticulate with dark fuscous dorsally.

Described from eleven live larvae collected in April and October at Clarksville, Tenn. Moths determined by F. H. Benjamin.

Food: Dead leaves of deciduous trees.

Distribution: New York to Virginia and westward to Missouri and Tennessee.

Chytolita Grote

This genus is very close to *Zanclognatha*, differing only in having a longer and more slender spinneret, and in the angle formed at A^2 by setigerous tubercles $A^1-A^2-A^3$, this angle being slightly acute in *Chytolita* and slightly obtuse in *Zanclognatha*. From the standpoint of larval structure, these two genera are scarcely distinct.

Three species are credited to this genus.

Chytolita morbidalis Guenée

Pl. XXIV, Fig. G; Pl. XXV, Fig. D.

Head 2 mm. broad. Body about 16 mm. long and 3.5 mm. broad at middle. General color a pale leaf brown tinged with pink.

A dark middorsal stripe. Body throughout with a bright red reticulation which forms an indefinite sinuous subdorsal line, the interstices of the reticulation pale yellowish brown. Setigerous tubercle I in a definite, round, subdued pale area on each abdominal segment. No pale spot dorsad of II or posterior to III on any abdominal segment. Spiracles entirely black, except that the extreme upper edge of the rim is pale brownish. There are no large granules in the interstices of the reticulation. Head pale, closely reticulate with brownish red.

Described from many live larvae collected during February and March at Clarksville, Tenn. Moths determined by F. H. Benjamin.

Food: Dead leaves of deciduous trees.

Distribution: Nova Scotia, Massachusetts, Maryland, and North Carolina westward to Wyoming, Colorado and New Mexico.

From two larvae collected April 8, 1925, at Clarksville, Tenn., a moth, doubtfully determined as *Chytolita petrealis* Grote by F. H. Benjamin, was reared. These larvae were not distinguishable from those of *morbidalis*.

PLATE XIX. LARVAL STRUCTURES.

- A. *Scolecocampa liburna*: Head of larva, anterior view, showing arrangement of setae.
 B. *Scolecocampa liburna*: Head of larva, lateral view, showing arrangement of setae.

Explanation of symbols used in Figures A and B

A^1, A^2, A^3 , anterior setae
AdfA, adfrontal area
Adf¹, Adf², adfrontal setae
E¹, E², epistomal setae
F, front
F¹, F^a, frontal seta and puncture
L¹, lateral seta
ML, median line
O¹, O², O³, ocellar setae
P¹, P², posterior setae
SO¹, SO², subocellar setae
I, II, III, IV, V, VI, ocelli
 Punctures are but rarely visible in the Hypeninae.

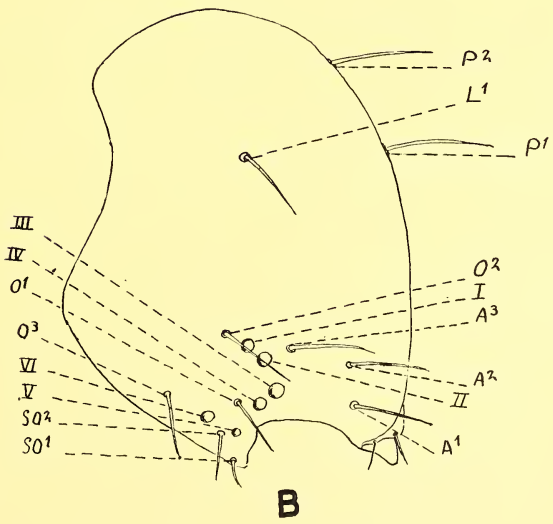
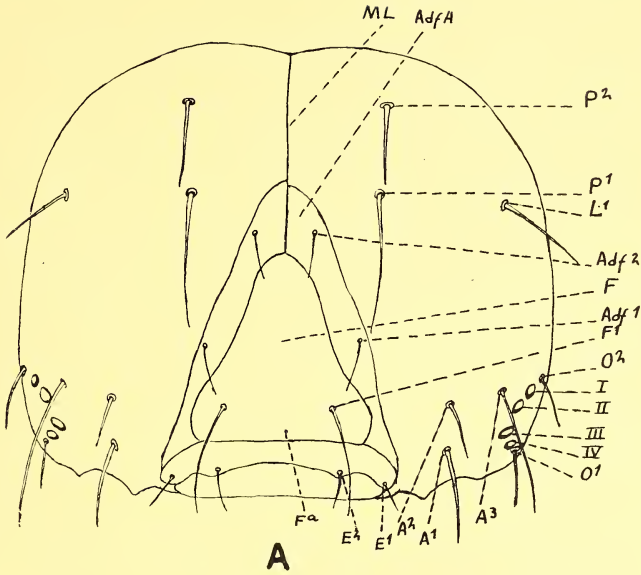
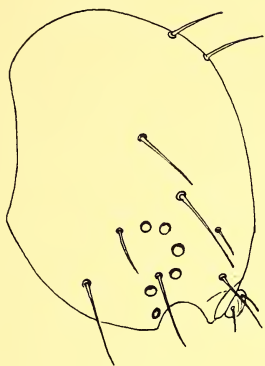
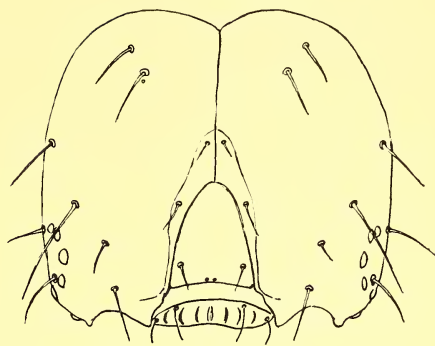


PLATE XX. LARVAL STRUCTURES

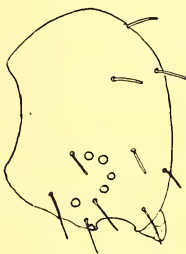
- A. *Platyhypena scabra*: Head of larva, lateral view, showing arrangement of setae.
- B. *Platyhypena scabra*: Head of larva, anterior view, showing arrangement of setae.
- C. *Epizeuxis lubricalis*: Head of larva, lateral view, showing arrangement of setae.
- D. *Epizeuxis lubricalis*: Head of larva, anterior view, showing arrangement of setae.
- E. *Renia discoloralis*: Head of larva, lateral view, showing arrangement of setae.
- F. *Renia discoloralis*: Head of larva, anterior view, showing arrangement of setae.



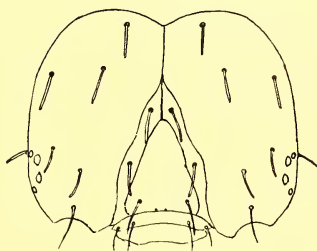
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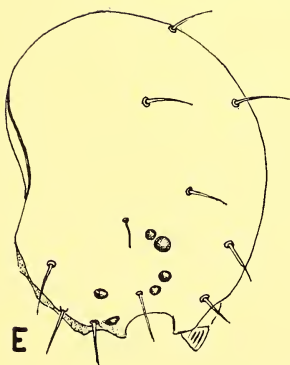
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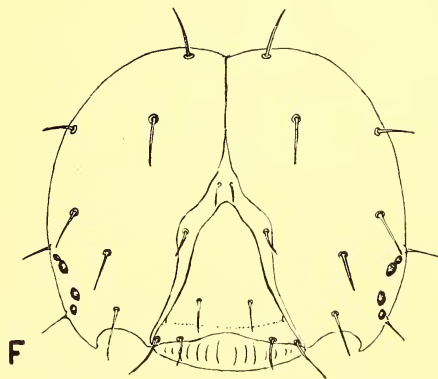
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D



E



F

PLATE XXI. LARVAL STRUCTURES.

- A. *Epizeuxis lubricalis*: Setal map of prothorax (TI), mesothorax (TII), first abdominal segment (A1), third abdominal segment (A3), seventh abdominal segment (A7), eighth abdominal segment (A8), and ninth abdominal segment (A9). Seta I^c is absent on the prothorax in this species.
- B. *Scolecocampa liburna*: Portion of venter of first abdominal segment showing arrangement of setae.
- C. *Metalectra quadrisignata*: Portion of venter of first abdominal segment showing arrangement of setae.
- D. *Diallagma latiorella*: Portion of venter of first abdominal segment showing arrangement of setae.
- E. *Bleptina caradrinalis*: Portion of venter of first abdominal segment showing arrangement of setae.
- F. *Hyppena decorata*: Portion of venter of first abdominal segment showing arrangement of setae.
- G. *Hormisa litophora*: Portion of venter of first abdominal segment showing arrangement of setae.
- H. *Renia discoloralis*: Portion of abdominal segment 9 showing setigerous tubercle and seta III normal, of the same character as I and II.
- I. *Agrotis c-nigrum*: Portion of abdominal segment 9 showing setigerous tubercle and seta III modified, different in character from I and II.

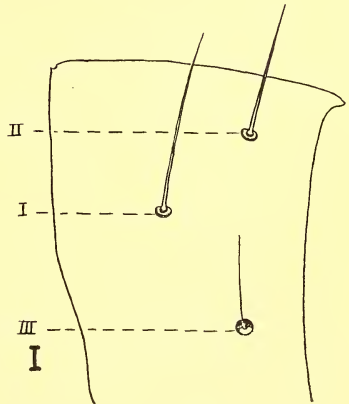
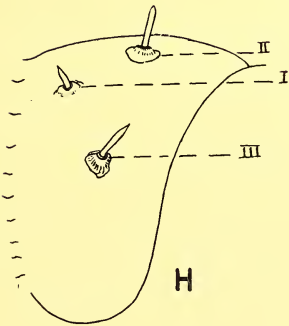
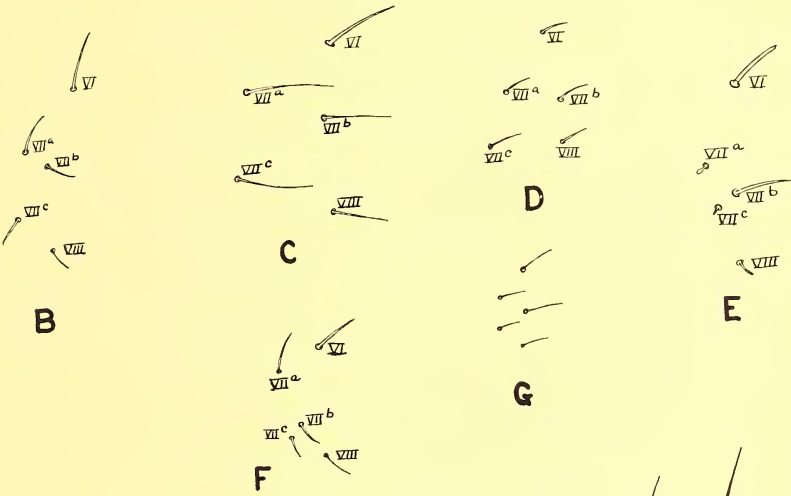
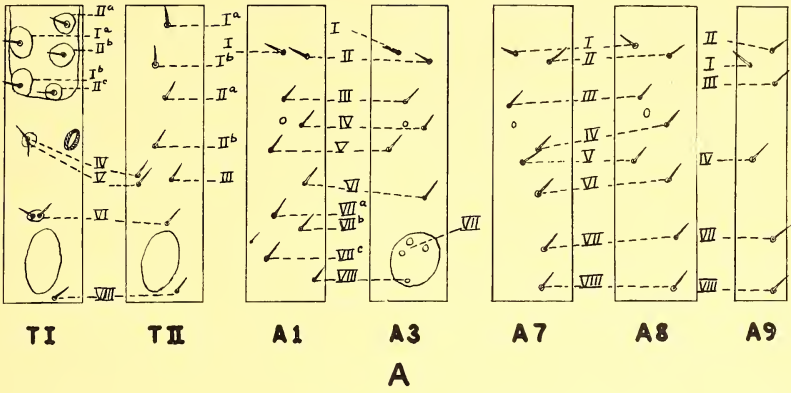


PLATE XXII. LARVAL STRUCTURES.

- A. *Alabama argillacea*: Portion of abdominal segment 6, lateral view, showing arrangement of setae.
- B. *Hypena californica*: Abdominal segment 2, ventral view, showing arrangement of setae and confluent setigerous tubercles.
- C. *Scolecocampa liburna*: Portion of abdominal segment 6, lateral view, showing arrangement of setae.
- D. *Scolecocampa liburna*: Abdominal segment 2, ventral view, showing arrangement of setae and confluent setigerous tubercles.
- E. *Epizeuxis lubricalis*: Portion of fourth abdominal segment, lateral view, showing arrangement and orientation of setigerous tubercles.
- F. *Renia sobrialis*: Portion of mesothorax, lateral view, showing character and arrangement of setigerous tubercles.
- G. *Platyhypena scabra*: Portion of mesothorax, lateral view, showing character and arrangement of setigerous tubercles.
- H. *Euxoa scandens*: Abdominal segment 1, ventral view, showing arrangement of setae and the absence of seta VII^c.
- I. *Zale* sp.: Abdominal segment 1, ventral view, showing arrangement of setae and the presence of seta VII^c.

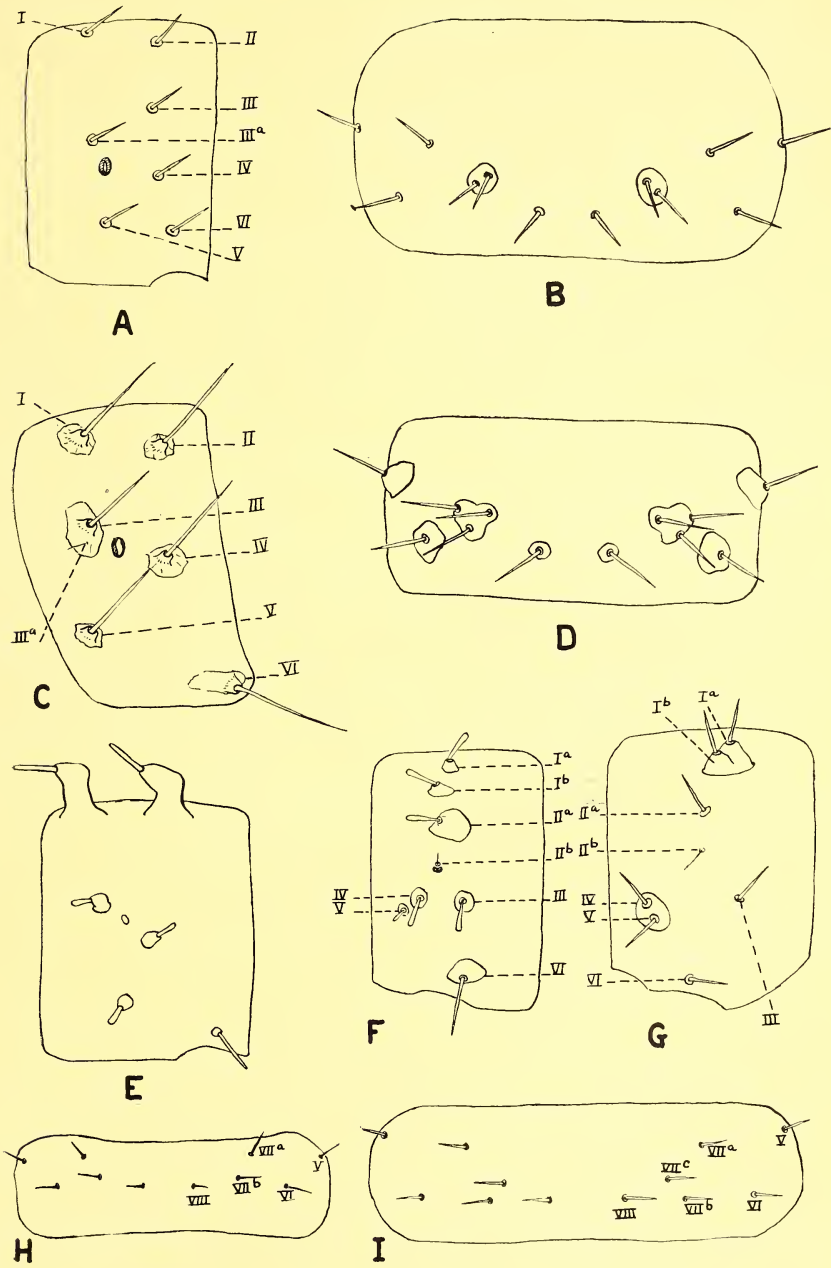


PLATE XXIII. LARVAL STRUCTURES.

- A. *Zanclognatha cruralis*: Portion of prothorax, lateral view, showing relation of cervical shield, spiracle, and prespiracular shield. *Cs*, cervical shield; *Sp*, spiracle; *Ps*, prespiracular shield. In this species and in those figured in B, C, and D seta I^c is absent on the cervical shield and V is absent on the prespiracular shield.
- B. *Renia discoloralis*: Portion of prothorax, lateral view, showing relation of cervical shield, spiracle, and prespiracular shield.
- C. *Bleptina inferior*: Portion of prothorax, lateral view, showing relation of cervical shield, spiracle and prespiracular shield.
- D. *Renia salusalis*: Portion of prothorax, lateral view, showing relation of cervical shield, spiracle, and prespiracular shield.
- E. *Epizeuxis americalis*: Portion of prothorax, lateral view, showing relation of cervical shield, spiracle, and prespiracular shield. In this species seta I^c is absent on the cervical shield.
- F. *Epizeuxis lubricalis*: Prothoracic spiracle.
- G. *Renia flavipunctalis*: Prothoracic spiracle.
- H. *Phalaenophana pyramusalis*: Posterior extremity of abdomen, posterior view, showing relation of setae. *Al*, antero-lateral seta; *Da*, dorso-anterior seta; *Pl*, postero-lateral seta; *Pm*, postero-median seta; *SaS*, subanal seta.
- I. *Palthis asopialis*: Posterior extremity of abdomen, posterior view, showing relation of setae. *SaS*, subanal seta.

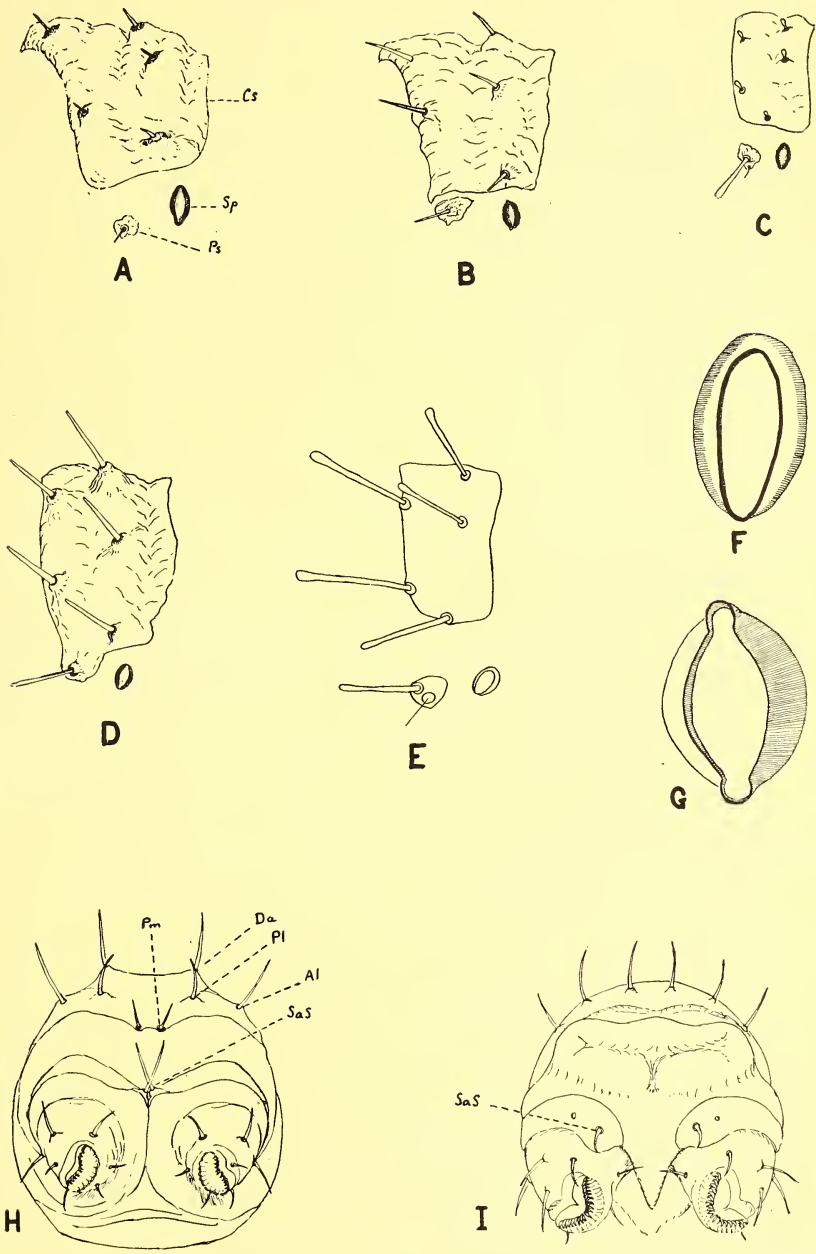


PLATE XXIV. LARVAL STRUCTURES.

- A. *Phalaenostola laurentioides*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- B. *Philometra metonalis*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- C. *Hormisa litophora*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- D. *Palthis asopialis*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- E. *Renia factiosalis*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- F. *Phalaenophana pyramusalis*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- G. *Chytolita morbidalis*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- H. *Renia discoloralis*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- I. *Bleptina inferior*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- J. *Zanclognatha pedipilalis*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- K. *Diallagma latiorella*: Dorsum of abdominal segment 5, lateral view, showing character of tubercles and setae I and II.
- L. *Epizeuxis forbesi*: Tarsus, showing character of apical setae.
- M. Spiracles from third abdominal segment, showing relative size and emarginate ends. *a*, *Renia sobrialis*; *b*, *Bleptina inferior*; *c*, *Zanclognatha cruralis*; *d*, *Palthis asopialis*.
- N. Spiracles from third abdominal segment, showing relative size and non-emarginate ends. *a*, *Epizeuxis rotundalis*; *b*, *Epizeuxis aemula*; *c*, *Epizeuxis americalis*; *d*, *Epizeuxis lubricalis*.
- O. *Epizeuxis rotundalis*: Tarsus, showing character of apical setae and length of tarsus.
- P. *Epizeuxis lubricalis*: Setigerous tubercle I.
- Q. *Epizeuxis lubricalis*: Tarsus, showing character of apical setae and length of tarsus.
- R. *Epizeuxis julia*: Tarsus, showing character of apical setae and length of tarsus.
- S. *Zale* sp.: Portion of dorsum of abdominal segment 8, lateral view, showing setigerous tubercles I and II.

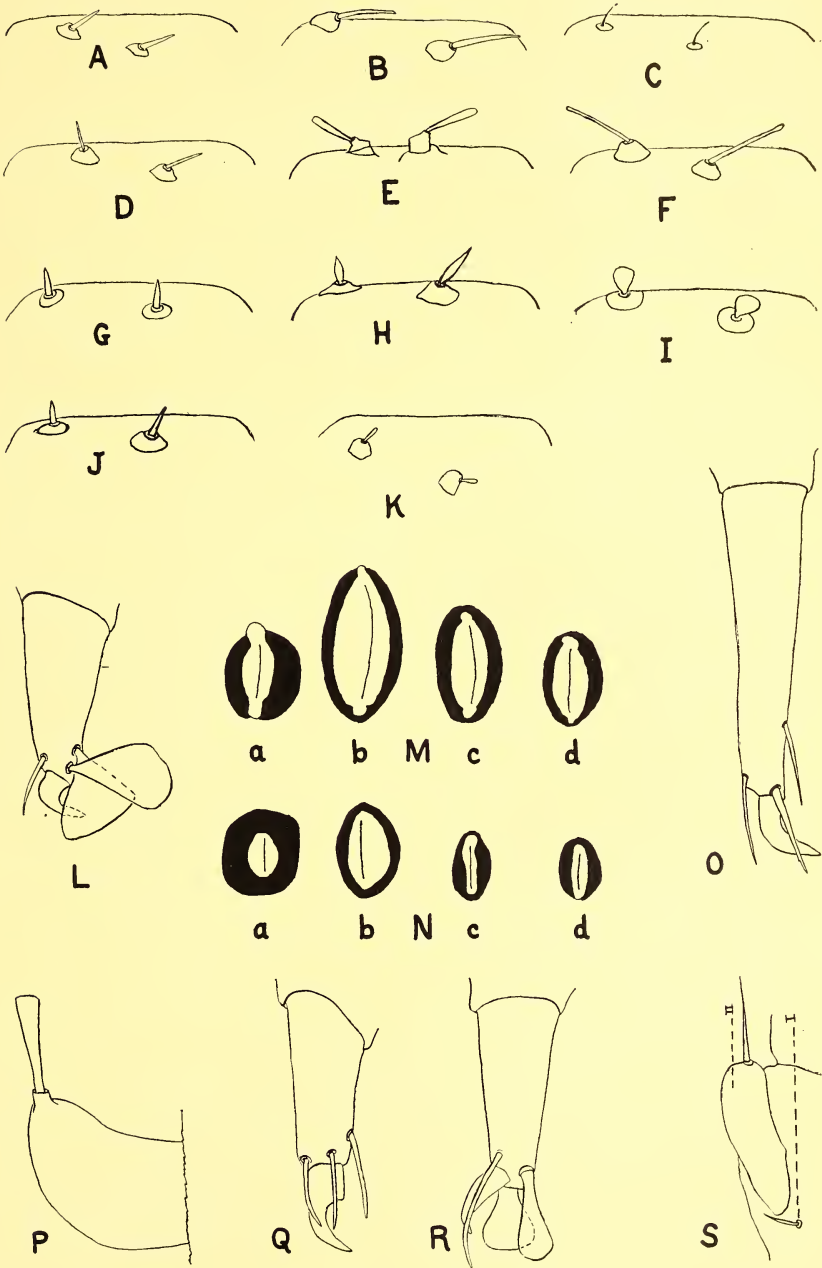
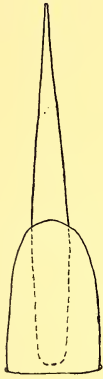
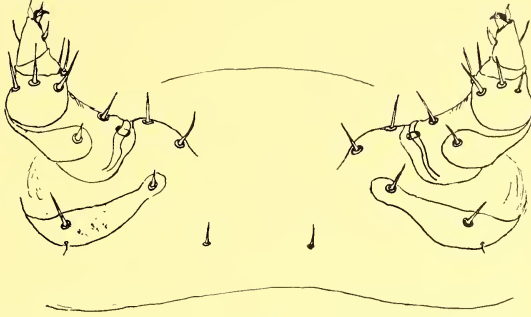


PLATE XXV. LARVAL STRUCTURES.

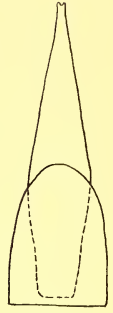
- A. *Platyhypena scabra*: Spinneret.
- B. *Renia discoloralis*: Metathorax, ventral view, showing coxae widely separated.
- C. *Hypena decorata*: Spinneret.
- D. *Chytolita morbidalis*: Spinneret and labial palpi.
- E. *Platyhypena scabra*: Metathorax, ventral view, showing coxae not much separated.
- F. *Zanclognatha cruralis*: Spinneret and labial palpi.
- G. *Feltia subgothica*: Crochets on proleg, showing uniordinal arrangement.
- H. *Hypena californica*: Labial palpus, showing character of papilla (P).
- I. *Autographa verruca*: Crochets on proleg, showing biordinal arrangement.
- J. *Palthis asopialis*: Portion of skin highly magnified, showing character of skin granules.
- K. *Epizeuxis rotundalis*: Labial palpus, showing character of papilla (P).



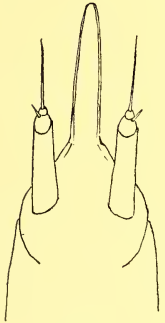
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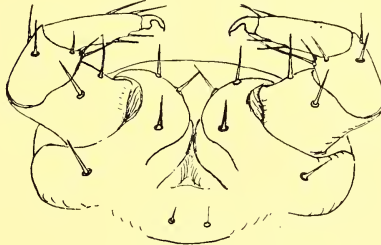
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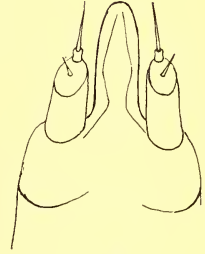
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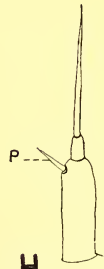
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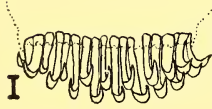
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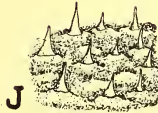
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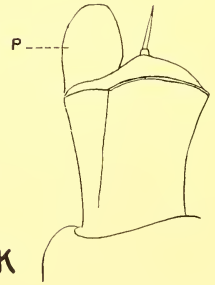
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ENTOMOLOGICA AMERICANA

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